POWER

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A LETTER from the chief engineer of a large institution details some of the difficulties experienced by his class in dealing with advertisers.

If, in asking for information or a catalog, the engineer writes on a postal card or "store stationery," giving his home address, his request may meet with little attention, especially if the catalog is of some value or the furnishing of the information desired involves some trouble and expense.

The advertiser, unable directly to identify the inquirer with some responsible position and a prospective sale, gives it scant attention. He does not want to lumber up his prospect list with names of which he does not know the meaning or to be playing a line at the other end of which a wily competitor may be playing pranks.

If, on the other hand, he writes on the stationery of the company, firm or institution giving his name and position the probability is that the injunction to "address all communications to the company, not to individuals" will be followed and the desired information arrives as an apparently impersonal piece of advertising literature, in which the young person who sorts the mails can see no imaginable interest to anybody.

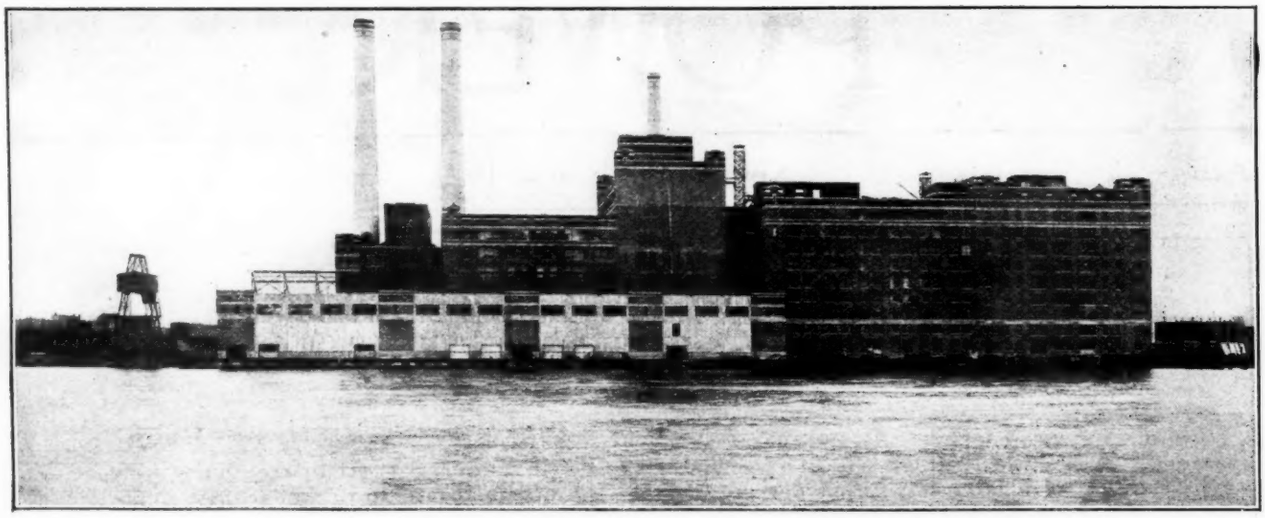
He cites a service paper issued periodically by the manufacturer of apparatus under his charge and which is of value and interest to him. It comes, however, addressed simply to the institution, and notwithstanding repeated instructions to the office, it is only by constant vigilance that he is able to prevent it from being burned in its wrapper.

Again, an engineer with no immediate intention of requisitioning or recommending the purchase of a piece of apparatus, but in an honest effort to keep himself informed in regard to it, will request information as to capacities, efficiencies, sizes, prices, etc., that it may be available when needed. If he writes such a request on the company's stationery, he is liable to be summoned to the manager's office to explain to a disappointed salesman that he was not soliciting bids for the company but keeping up his own file.

That these conditions are somewhat general we know from listening in on expressions from both sides. We should like to have discussion, especially from the advertisers. It may serve to amplify the returns from advertising and lead to more cordial relations between advertisers and possible purchasers. For it is the engineer who uses the goods, is it not, in whose mind it is desirable to create that condition of favorable interest in them that leads to a sale, or to whom information regarding their operation and maintenance should be gotten to insure their successful and satisfactory service?

The writer of the letter referred to assumed that the publishers of the service paper preferred to send it to their customer —the institution—rather than to him, the engineer of the institution today but perhaps not tomorrow. The probability is that a note explaining the conditions would have resulted in a personally addressed copy. Advertisers are glad to supply information regarding their wares for engineers' files, but it saves them expense and embarrassment if the request makes it evident that it is only the information that is at present desired.

F. R. Low



Boiler Plant of the American Sugar Refining Company, Baltimore, Md.

SITUATED at Locust Point on the Patapsco River, at Baltimore, Md., is the new refinery of the American Sugar Refining Co. This plant is the most modern cane-sugar refinery in the country and is excellently situated for the receiving of coal and the transportation of the refinery products by rail, highway, or water. It is the purpose of this article to deal only with the design and operation of the boiler plant.

As in all plants of this kind the refining of the sugar is a heat process from start to finish. This requires large quantities of live and exhaust steam, consequently the reliable operation of the boiler plant and the cost of steam production are of vital importance. In this installation, however, exhaust steam is being utilized to a much greater extent than in any other refinery yet built.

Before deciding on the type of equipment for the boiler plant, a careful survey was made of the different coals commercially available, and this resulted in the selection of what is commonly known as Creek coal. This coal is dredged from the river beds in the anthracite coal region of Pennsylvania. As received, it consists largely of No. 4 buckwheat, and the proximate analysis is as follows: Fixed carbon, 73 per cent; volatile matter, 6; ash, 20; sulphur, 1 per cent. Its heat value, air-dried basis, is 11,600 B.t.u. This coal, while being low in price, has the advantages of being free from deterioration in storage, and cleanliness in handling. The traveling chain grate was chosen as being the most satisfactory type of stoker for this grade of coal, and also readily adaptable to other fuel should occasion arise. Firing with powdered coal and fuel oil was given due consideration, and provision was made in the plant design for the installation of this equipment with slight alteration, if considered advisable.

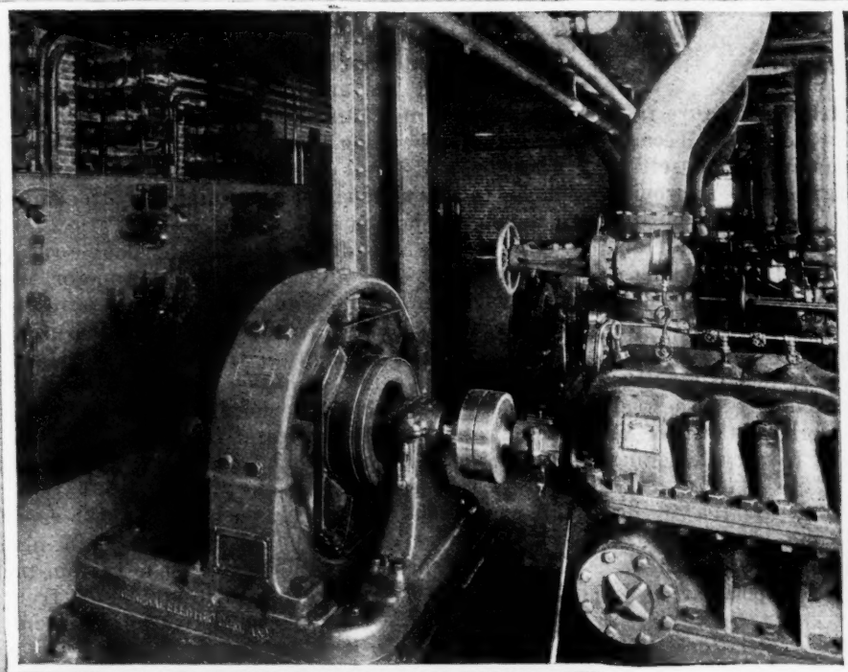
THIS refinery represents the latest practice in industrial plant design. The boiler plant contains 5 boilers of 12,060 sq.ft. heating surface each plus 26 per cent integral economizer surface, fired by forced-draft chain-grate stokers. The fuel is small-sized anthracite "creek coal." The furnace is designed to improve the gas mixture and decrease the carbon loss to the ash-pit. Cooling air for furnace arches is used as preheated excess air in combustion chamber.

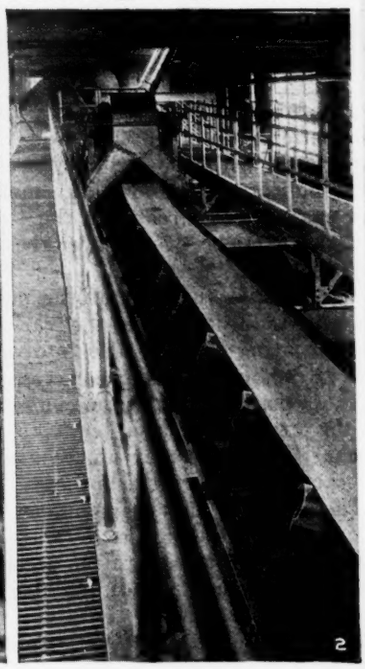
It was estimated that the present average steam demand of the refinery would be around 250,000 lb. per hour with a possible maximum demand of 300,000 lb. It is also expected that future developments will increase this demand possibly 50 per cent. The steam requirements are subject to wide fluctuations through the day, so that sufficient steam-generating capacity has to be carried continuously to take care of the maximum demand. The boilers on the average, however, will be operated at only moderate ratings. These conditions warranted the selection of fairly large-sized units, and the adoption of the bent-tube type of boiler with the integral economizer section was influenced largely by its high efficiency at moderate ratings and freedom from clogging of the heating surface from deposits of slag and ash.

In the headpiece is shown the refinery with boiler house to the left, as viewed from the Patapsco River. The boiler-house building is of structural-steel frame, with brick walls and reinforced-concrete flooring and is of architectural design to harmonize with the refinery buildings. The dimensions of the present boiler house are 111 ft. wide by 132 ft. in length and 125 ft. in height from the ground floor to the top of the coal bunker. The ultimate design calls for a building length of 170 ft. The building footings rest on a concrete mat supported on closely spaced wood piling.

By referring to the cross-section, it will be seen that the design of the building provides liberal daylight illumination, and for this reason the coal bunker has been raised somewhat higher than the usual practice. This allows the placing of con-

Boiler Room Firing Aisle, Auxiliaries and Coal-Handling Equipment





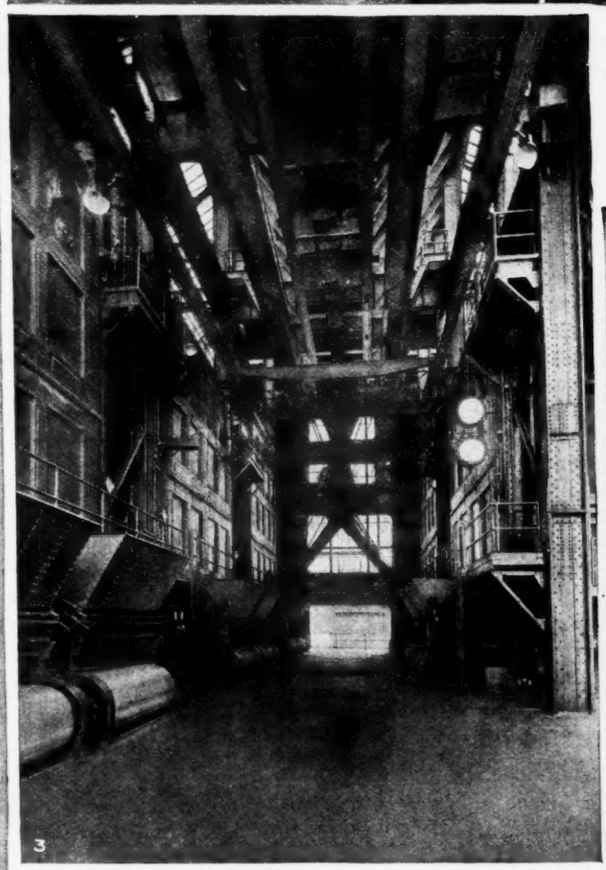
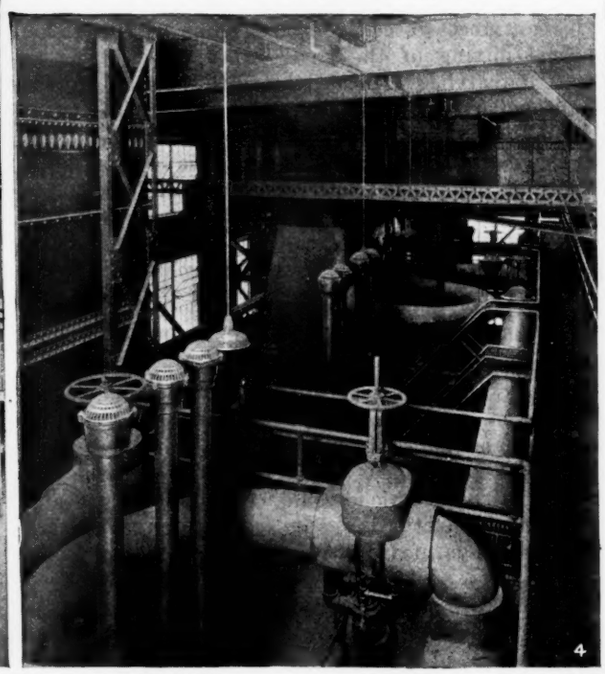


Fig. 1. Feed pumps and electric control panels. Four pumps, of the four-stage centrifugal type, are installed.

Fig. 2. From the bucket conveyor coal is distributed to the different sections of the bunker by a 24-in. belt conveyor and automatic tripper; capacity 200 tons per hour.

Fig. 3. View looking down firing aisle. There are five 12,060-sq.ft. Stirling type boilers with 26 per cent integral economizer surface. Each boiler is fired with two chain-grate stokers.

Fig. 4. Each boiler is equipped with an automatic non-return valve and eight 4½-in. pop safety valves.



tinuous skylights at either side. A large window area has also been provided in the building walls and has resulted in an exceptionally well lighted and ventilated boiler house.

The present boiler installation consists of five 12,060-sq.ft. boilers of the Stirling type with a 26 per cent integral economizer surface. They are fired with two traveling-grate stokers with a total area of 317.5 sq.ft., giving a ratio of water-heating surface to grate area of 38 to 1.

Furnace of Special Design

The furnace construction is a marked departure from conventional designs. This was very desirable because experience with the ordinary stoker and arch setting has indicated considerable margin for improving gas mixtures and reducing the loss due to the hurling of small particles of coal over the rear of the grate and through the boiler passes.

The arch at the rear of the stoker was installed to prevent radiation from the rar of the grate to the boiler-heating surface, also to divert forward the products of combustion and the excess of air that is required in this area to clean up the combustible left at the rear of the grates. It also tends to increase the rate of combustion at the rear of the grate, thereby lessening the carbon loss to the ashpit.

The "reverse" flow of gas under the rear arch carries the fine particles of coal forward, and in making the abrupt upward turn into the secondary chamber, redeposits a large portion of the fine coal upon the grate where it is consumed.

The arch is provided with forced ventilation, as it will be seen that it projects into the furnace at the hottest zone. The air is taken directly from the main forced-draft air duct and flows through passage *A*. After traversing the arch through chamber *B*, it passes forward through the center and side walls and is admitted to the furnace between the first and second front arches at *C*. This preheated air with the excess of air from the rear of the stoker tends to envelop the partly consumed gases from the front of the stoker. The final mixing of the gases takes place under the upper front arch, which also tends to deflect the gases into the boiler-heating surface.

Although tests have not yet been made to determine the efficiency of the furnace layout as a gas mixer, observations of flame travel and exit-gas temperature indicate that the furnace is functioning as expected. The front row of boiler tubes shows practically no clinker deposit, indicating complete combustion within the boiler furnace.

Arches Built of Small Sized Brick

The arches, with the exception of the fantail ignition sections, are laid up of special wedges of double-burned high alumina New Jersey brick. The brick are wedges 9 in. long and approximately the size of a standard firebrick. Small shapes were used to overcome the tendency to spall, which would be greatly aggravated by the widely fluctuating furnace temperatures occasioned by swings of from 50 to 150 per cent of boiler rating.

The arches are substantially supported by heavy steel buckstays and skewbacks. After several months' service examination of the noses and crowns of the arches shows no tendency to spall or develop expansion cracks.

In these furnaces considerable volume was sacrificed in order to force the products of partial combustion and excess air to take a swirling motion rather than a stream-line motion such as exists in the ordinary furnace.

No superheaters are installed. The steam is taken off the rear drum, which decreases the liability to prime under heavy sudden demands.

It will be seen that liberal aisle space has been provided between the boilers. The operating floor is free of all equipment except the boiler and stokers, with their individual motor drives and instrument panels. Practically all the auxiliaries have been grouped together on the mezzanine and basement floors on the west side of the building, the other side being used for offices, laboratories, etc. The grouping of the auxiliaries in this manner tends to minimize attendance and to centralize the control.

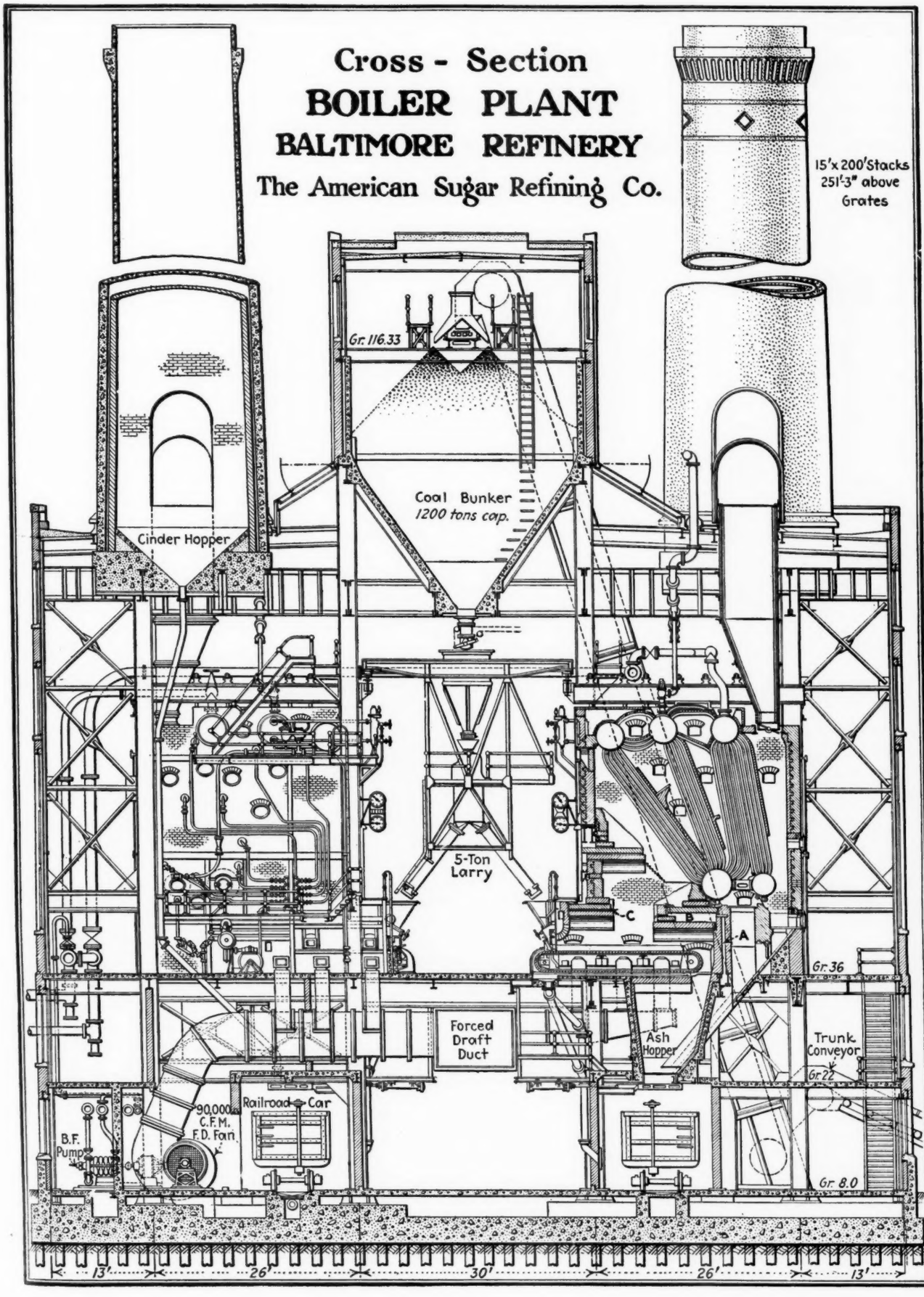
The stokers are driven through a double-reduction wormwheel by a 2¼-hp. variable-speed motor with a speed variation from 500 to 2,000 r.p.m. A still greater speed ratio of 8 to 1 is obtained by means of a step pulley. This gives a grate travel of 8 to 64 ft. per hour, the latter being the highest on record for this type of stoker. This wide variation in travel makes possible the operation of the boilers at ratings from 35 to 250 per cent and a fuel consumption of 10 to 60 lb. per sq.ft. of grate surface per hour.

Air for combustion is supplied by three turbo-vane fans each with a capacity of 90,000 cu.ft. per min. against 5½-in. water pressure and driven by a 125-hp. motor. The fans will normally draw their air supply from the ash alleys, but adjustable louver openings from the mezzanine floor are provided for ventilation. The speed of the fans is dependent upon the steam pressure. With a drop in pressure the fans speed up, automatically increasing the supply of air to the stokers. The windboxes under the stoker grates are divided into six compartments, as in the case of progressive combustion more air is needed where coal is fed onto grates than in the region where ash is formed. The pressure in each compartment is regulated by means of a slide grate in branches coming off the main air duct. The speed of the fan is adjusted so as to give an excess of ¼-in. water pressure in the main duct over that required in the first compartment. A multi-tube draft gage indicates the air pressure in each compartment. The speed of the stoker grates is controlled manually by means of a drum controller. A tachometer with a range of from 0 to 75 ft. per hour indicates the grate speed and is attached to the instrument board in front of each boiler. Balanced-draft system of damper control is automatic and is operated by compressed air. This maintains a suction of 0.05 in. over the fire. The draft loss through the boiler is indicated by a gage showing the draft over fire and in the smokebox next to the damper.

The ashes discharged at the rear end of the stoker fall into brick-lined ashpits of reinforced concrete, having a capacity for 16 hours' operation. The bottoms of the hoppers are equipped with air-operated gates, and the ashes are discharged directly into standard railway cars.

Boiler Instruments

Each boiler is equipped with a boiler meter recording steam output, rate of air flow and flue-gas temperature. This instrument, together with the electric tachometers previously mentioned, is mounted on a small slate panel and located at one side and in front of the boiler units.


Cross - Section
BOILER PLANT
BALTIMORE REFINERY
The American Sugar Refining Co.
15'x 200' Stacks
251'-3" above
Grates
Gr. 116.33
Coal Bunker
1200 tons cap.
Cinder Hopper
5-Ton
Larry
C
B
A
Gr. 36
Forced
Draft
Duct
Ash
Hopper
Trunk
Conveyor
Gr. 22
90,000
C.F.M.
F.D. Fan
Railroad Car
B.F.
Pump
Gr. 8.0
13'
26'
30'
26'
13'

There are also several indicating and recording instruments used to record the performance of the feed-water and other boiler-house equipment. These are located close to the equipment to which they are connected. The boilers are also equipped with automatic feed-water regulators and 18-element mechanical soot blowers.

At either side of the main operating aisle are mounted illuminated master gages, which indicate the pressures and rates of steam flow in the two distributing mains leading from the boiler house to the power house and the refinery respectively. Located between one set of these gages is an illuminated number signal operated from a point in the refinery to notify the stoker operator of exceptional changes in load.

Steel-plate breechings lined with 2-in. insulation connect the boilers to two reinforced-concrete stacks, each 15 ft. inside diameter at the top and 250 ft. in height above the grates. The stacks are superimposed on the building steel at the roof level, and they are brick-lined to a height of 50 ft. The cross-sectional area of each stack at the base is 0.166 sq.ft. per sq.ft. of ultimate grate served, and they are designed to withstand a wind pressure of 100 miles per hour and to give a draft at the base of 1.2 in. approximately.

The base of the stack is provided with a soot chamber, from which a 7-in. pipe is run to a convenient point in the ash-loading alley. Provision has been made above each boiler for the installation of cinder catchers and additional economizer surface if deemed necessary at some future time.

Coal Handling Equipment

Coal for the plant is normally received by rail and delivered to the Baltimore & Ohio elevated track adjacent to the plant, and from there it is dumped from bottom-dump cars to company-owned barges, which are hauled a short distance to the point of unloading by electrically driven winches located along the bulkhead. The coal is unloaded from the barges by a 2-yd. clamshell bucket operated from an electrically operated traveling tower of the cantilever-beam type capable of unloading from the barge to storage or direct to the conveyor. The coal is also recovered from storage in the same way. The distribution of the yard storage of 25,000 tons is done by a locomotive crane.

From the unloading bucket the coal passes through a 2-roll crusher, located in the base of the tower or is bypassed and delivered to a 30-in. belt conveyor of 200 tons capacity and driven by a 20-hp. direct-current constant-speed motor.

From this conveyor the coal is elevated by a double-chain fixed-bucket type elevator of 200 tons capacity, to the top of the boiler house and delivered to a 24-in. belt, which conveys it over the firing aisle into the bunker, which is of reinforced-concrete construction and has a capacity of 11 tons per linear foot, or a total capacity of 1,200 tons. A traveling automatic tripper unloads the belt into the bunker at any desired point. This flight conveyor has a capacity of 200 tons an hour when traveling 350 ft. a minute and is driven by a 15-hp. constant-speed motor.

Coal Weighed by Automatic Scale

Distribution of the fuel to the individual stoker hopper is by means of an electrically operated automatic weighing larry of 5 tons capacity. A number of openings in the bottom of the bunker are provided with chain-operated gates and permit coal to be taken from any part of the bunker.

Representative samples of the coal are taken from the cars as they are unloaded and a proximate analysis made from them. A sample of each day's ash is also secured and an analysis made for percentage of combustible.

Adjacent to but separated from the boiler room is the power house on the main floor of which are installed three generating units. The engines are of the twin-simple four-valve type and exhaust against 10 lb. back pressure. They are direct-connected to 1,250-kw. compound-wound 240-volt 3-wire direct-current generators and operate at 135 r.p.m. The steam supplied to the engines is dry saturated at 200 lb. pressure. These units have a guaranteed steam consumption of 35.9 lb. per kw.-hr. with an initial steam pressure of 200 lb. and a back pressure of 10 lb. gage.

Entrained Air Removed from Makeup Water

The exhaust steam on leaving the engines passes through a horizontal oil separator fitted with removable trapping sheets before passing to the refinery for process work. A pressure of 1 lb. or over is maintained on the condensation returns to guard against the reabsorption of air. The condensate from the refinery is returned at a temperature around 200 deg. to a storage tank of 12,000 gal. capacity, whence the water is again pumped to the boilers.

A deaërator is used to remove the entrained air from the fresh makeup water, and also raise the temperature to about 190 deg. The makeup water, which under normal operating conditions amounts to about 10 per cent of the total feed, is taken from the city supply and first fed to a pressure tank and there raised to the boiling point. The steam thus generated passes to a vacuum tank, where the air is removed by a steam ejector; the discharge from the vacuum section is condensed and returned under float control and at a temperature around 190 deg. to the returns tank. A reserve supply of 15,000 gal. of deaërated water is held for boiler filling and for emergency use.

If for any reason the quantity of makeup water required exceeds the capacity of the deaërating system and the reserve of 15,000 gal., an independent closed-type high-pressure heater is automatically brought into service. The water is supplied directly from the city mains and is regulated by a float-controlled valve, which works in conjunction with a motor-operated steam valve, admitting steam to the heater simultaneously with the water, after which the temperature is thermostatically controlled.

Feed Water System

Boiler-feed pump reserve capacity is liberally provided. There are four pumps of the four-stage centrifugal type located in the basement at the rear of the boilers and below the storage tank, from which the feed water is supplied. There is one 4-in. 350-gal. per min. pump driven by a 100-hp. steam turbine, one 4-in. 350-gal. per min. pump driven by a 125-hp. direct-current motor, and two 5-in. 750-gal. per min. pumps driven by 200-hp. motors, all operating against a pressure of 250 lb. All pumps are automatically controlled. In the case of the motor-driven pumps the regulator operates directly on the speed-controlling rheostat of the motor through a rack and quadrant. Two 8-in. Venturi meters are installed to measure the water feed to the boilers.

All piping has been laid out with a view toward securing maximum simplicity with a minimum of duplication necessary for the continuity of operation. The main steam header is in the form of a loop, one side of which is located above the east row of boilers, and the other placed about 3 ft. above the floor at the rear of the west row of boilers. All piping is arranged with ample room for maintenance and access. Provision has been made for feeding each side of the loop separately with a regulating valve between. A pressure of 200 lb. will normally be carried in each main. A considerable variation in pressure can take place in the refinery main without affecting the refining process, as any pressure above 110 lb. will meet all requirements. The main high-pressure steam piping has cast-steel fittings and valves with rolled-steel Van Stone flanges on the pipe.

The Holly system has been used for high-pressure drips, which are taken off at several points on the main header and returned directly to the boilers. Condensate from the exhaust mains is collected in traps and discharged through oil filters to the supply tanks.

To further guard against possible corrosion of the steel economizers, due to the reabsorption of air, the temperature of the feed water is maintained as near 212 deg. as possible. In order to insure this temperature being maintained, the supply tank is fitted with removable type heating coils, which are supplied with low-pressure steam under thermostat control.

Great care has been exercised in the insulation of all steam and hot-water lines as well as all other parts of equipment where heat losses would occur. Eighty-five per cent magnesia has been used throughout and is covered with 8-oz. canvas. Further details are given in the list of equipment.

For general purposes around the plant and the operating of ash gates and damper regulators, a 200-cu.ft. per min. motor-driven air compressor is located with the other auxiliaries in the boiler-house basement. In addition to this, one 200-cu.ft. per min. and two 420-cu.ft. per min. compressors are installed in the engine room, all single-stage and motor-belt driven.

At the present time preparations are being made for a series of tests, when special effort will be made to obtain full information as to furnace performance in detail.

The boiler plant was designed and constructed by Stone & Webster, Inc., under the direction of the consulting board of the American Sugar Refining Company.

DATA ON PRINCIPAL EQUIPMENT IN THE BALTIMORE PLANT OF THE AMERICAN SUGAR REFINING COMPANY

Plant location	Locust Point, Baltimore, Md.
Character of service	Steam generation for both power and process service in sugar refining
Type of building	Brick walls, steel structure

BOILERS

Manufacturer	Babcock & Wilcox Co.
Type	Stirling with integral economizer section
Number, ultimate	8
Number installed	5
Width of firing aisle between stokers	17 ft. 6 in.
Width between boiler fronts	27 ft. 6 in.
Height of setting	34 ft. 3 in.
Width of setting	25 ft. 8½ in.
Length of setting	28 ft. 2⅝ in.
Water-heating surface per boiler sq.ft.	12,060
Heating surface per sq.ft. floor area, sq.ft.	5.18
Furnace volume cu.ft.	2,418
Ratio furnace volume to heating surface	1 to 5
Ratio furnace volume to grate surface	7.6 to 1
Size of tubes, in. diameter	3½
Boiler designed pressure lb. gage	250
Boiler operating pressure lb. gage	210
No. of passes, including economizer	4

COAL

Kind of fuel	Anthracite river coal—large percentage, No. 4 buckwheat
Heat value of fuel, B.t.u. per lb.	11,600 on dry basis
Proximate analysis: Ash, 20 per cent; volatile, 6; carbon, 73; sulphur, 1.0 per cent.	

STOKERS

Manufacturer	Combustion Engr. Corp.
Type	Coxe traveling grate
Number per boiler	2
Width	9 ft. 8½ in.
Length	16 ft. 4 in.
Total grate area, 2 stokers	317.5 sq.ft.
Drive	Double reduction worm wheel variable speed d.c. motor
Rate of combustion, lb. coal per sq.ft.	grate per hour 35 at 200 per cent rating
Draft	Natural
Forced-draft equipment	B. F. Sturtevant Co.
Type	Turbo-vane
Number	3
Capacity, cu.ft. per min. against 5½ in. water static pressure	90,000
Drive	125-hp. Gen. Electric variable-speed motor
Control	Pressure regulator, Ruggles-Klingemann

ECONOMIZERS

Manufacturer	Babcock & Wilcox Co.
Type	Steel tube
Location	Integral with boilers
Heating surface, sq.ft.	3,160
Sq.ft. economizer surface per sq.ft. boiler-heating surface	0.26

CHIMNEYS

Type	Reinforced concrete
Builder	Heine Chimney Co.
Number of boilers per stack, ult.	4
Height above grates	250 ft.
Inside diameter at base	16 ft. 10 in.
Inside diameter at top	15 ft.
Cross-section at base per sq.ft. of grate served	0.166 sq.ft. ult.
How supported	Superimposed on building steel
Designed to withstand lb. wind pressure	100 miles per hour
Draft at base, app., in.	1.2

COAL-HANDLING EQUIPMENT

Traveling electric coal tower	Maine Electric Co.
Capacity, tons per hour	200
One belt conveyor, 30 in.	Stephens-Adamson Mfg. Co.
Capacity at 270 ft. per min., tons per hour	200
Drive	20-hp. 240-volt motor
One belt conveyor, 24 in.	Stephens-Adamson Mfg. Co.
Capacity at 350 ft. per min., tons per hour	200
Drive	15-hp. 240-volt motor
One bucket elevator	Stephens & Adamson Mfg. Co.
Capacity, tons per hour	200
Drive	30-hp. 240-volt motor
One crusher, two-roll	Stephens & Adamson Mfg. Co.
Storage capacity, total, tons	30,000
Bunkers	Reinforced concrete, 1,200 tons
Capacity per lin. ft., tons	11
Method of reclaiming from storage	Industrial Traveling Crane, 90 ft. boom
Coal weighing	Automatic scale on coal larry, Richardson Scale Co.

ASH-HANDLING EQUIPMENT

Ash gates	Compressed-air operated
Manufacturer	Baker-Dunbar-Allen Co.
Ash disposal	Into standard railroad cars

BOILER FEED

Source and character of supply	90 per cent refinery returns (condensate), 10 per cent raw city water
Four boiler-feed pumps, Jeanesville type	Worthington Pump & Mch. Corp.
One 350-g.p.m., 4-in., 4-stage Terry turbine, 100 hp.	
One 350-g.p.m., 4-in., 4-stage motor-driven, 120 hp.	
Two 750-g.p.m., 5-in., 4-stage motor-driven, 200 hp.	
One feed-water heater, emergency service	Alberger Pump & Condenser Co.
Type	Wainright vertical, 100 lb. pressure
One make-up deaërator	Elliott Co.
Capacity, lb. per hour	26,000
Temperature at inlet, deg. F.	212
Temperature at outlet, deg. F.	190
Storage tanks	One 15,000-gal. deaërated water; one 12,000-gal. refinery returns

PRIME MOVER

Type	Twin side-crank 4-valve reciprocating engines, noncondensing
Manufacturer	Ridgway Dynamo & Engine Co.
Number (ultimate)	4
Number (installed)	3
Capacity each, rated kw.	1,250
Speed, r.p.m.	135
Pressure and temperature at throttle	200 lb. saturated steam, 10 lb. back pressure
Guaranteed performance	35.9 lb. per kw.-hr. at full load 39.0 lb. per kw.-hr. at half load 39.1 lb. per kw.-hr. at 25 per cent overload
Type of generator	Thompson-Ryan d.c. 240 volts

DATA ON PRINCIPAL EQUIPMENT IN THE BALTIMORE PLANT OF THE AMERICAN SUGAR REFINING COMPANY (Concluded)

PIPING

Steam piping	Van Stone joints, steel flanges, steel pipe
Piping contractors	Pittsburgh Valve & Foundry Co.
Oil separators, main exhaust	Direct Separators Co.
Oil separators, refinery returns	Griscom-Russell Co.

HEAT INSULATION

Specifications:	
High-pressure steam lines	Johns-Manville 85 per cent magnesia
Piping 5-in. diameter and over	3 in. thick
Piping under 5-in. diameter	2 in. thick
Low-pressure and exhaust lines	Covering 1½ in. thick
Hot-water lines	1½ in. thick
Cold-water lines	Hair felt 1 in. thick
Boiler drums	3 in. thick
Feed-water suction tank	1½ in. thick
All covering canvas	8-oz. duck
Pipe-covering material made and applied by	Johns-Manville Co.

AIR COMPRESSORS

Manufacturer	Worthington Pump & Mchy. Corp.
Service	General
Pressure, lb.	100 and 30
Number	4
Type	Laidlaw-Dunn-Gordon, single-stage, direct-acting, motor-driven
Capacity	Two at 100 lb., 197 cu.ft. of free air per min. each; two at 30 lb., 420 cu.ft. of free air per min. each

FIRE PUMPS

Manufacturer	Worthington Pump & Mchy. Corp.
Number	2
Type	One Epping-Carpenter, 150 g.p.m. One Underwriters, 1500 g.p.m.; duplex steam-driven direct-acting.
Pressure, lb.	200

METERS AND INSTRUMENTS

Each boiler is equipped with the following:

1 Bailey Recording and integrating steam-flow meter with air flow and flue-gas temperature	Bailey Meter Co.
1 balanced draft regulator damper control	Engineer Co.
2 Ashton illuminated dial pressure gages	Ashton Valve Co.
2 Stets-type feed-water regulators	Williams Gage Co.
1 Precision draft indicator	Precision Instrument Co.
2 Philo multi-tube draft gages	Schumaker-Sentry
18 element Diamond Soot blowers	Power Specialty Co.

AUXILIARY CONTROL:

Fans, Ruggles—Klingemann pressure regulators in conjunction with General Electric variable-speed motor control.
Feed Pumps, same.

FOR OPERATING DATA:

Total input of water to boilers—Two (2) Venturi Meters—Builders' Iron Foundry.
Total output of steam—Two (2) Republic flow meters with recording integrating and indicating meters. The indicating meters serving as load indicators for stoker operator. Republic Flow Meters Co.

RECORDING INSTRUMENTS: Brown Instrument Co.

Steam pressure
Feed-water pressure
Feed-water temperature
Air pressure, main air duct
Blow-down temperature
Refinery return temperature
Exhaust-steam pressure

INDICATING INSTRUMENTS: Foxboro Co.

Deaërator heater pressure
Deaërator heater temperature
Deaërator separator vacuum
Deaërator separator temperature
Miscellaneous Thermometers, Calodial

VALVE SCHEDULE

Type of Valve	Description	Sizes	Manufacturer
High-pres. gate	Screwed ends	¼ in. to 2-in., Inc.	
High-pres. gate	Steel body OS&Y, bronze mtd., flgd. ends	2½-in. and above	Pitts. Valve Fdy. & Const. Co.
Std. wt. gate	Bronze bodies, bronze seats and discs, scr. ends	¼-in. to 2-in., inc.	Pratt & Cady Co., Inc.
	OS&Y C.I. bodies, bronze mtd., scr. ends	2½-in. and 3-in	
Std. wt. gate	OS&Y C.I. bodies, bronze mtd., flgd. ends	4-in. and above	Pitts. Valve Fdy. & Const. Co.
High-pres. globe & angle	Screwed ends	¼-in. to 2-in., inc.	
High-pres. Globe & angle	Iron body, bronze mtd., flgd. ends	2½-in. and above	Pratt & Cady Co., Inc.
Std. wt. globe & angle	Iron body, bronze mtd., nickel seats & discs, scr. ends	¼-in. to 2-in., inc.	
	Iron body, bronze mtd., bronze seats & discs, scr. ends	2½-in. and 3-in.	The Lunkenheimer Co.
Std. wt. globe & angle	Iron body, bronze mtd., flgd. ends	4-in. and above	The Lunkenheimer Co.
High-pres. check	Screwed ends	¼-in. to 2-in., inc.	
High-pres. check	Iron body, bronze mtd., flgd. ends	2½-in. and above	Pratt & Cady Co., Inc.
Std. wt. check	Both horizontal and angle; iron body, bronze mtd., with renewable nickel seats and discs, scr. ends	¼-in. to 2-in., inc.	The Lunkenheimer Co.
	Iron body, bronze mtd., bronze seats & discs, scr. ends	2½-in. and 3-in.	
Std. wt. check	Horizontal iron body, bronze mtd., flgd. ends	4-in. and above	Pitts. Valve Fdy. & Const. Co.
Unions	All unions for 250 lbs. pressure cast iron—bronze seat, ground jnt. All rough bronze, grd. jnt.	¼-in. to 3-in., inc.	Crane Co.; The Lunkenheimer Co.
Gaskets	1/16-in. compressed asbestos, cut from garlock 900 sheets.	For all stm. lines both high and low-pressure	Garlock Packing Co.
	1/16-in. cloth inserted rubber gaskets	For water and liquor lines	
Safety	Pop, eight per boiler,	4½-in.	Consolidated Safety Valve Co.
Blow-off	One everlasting		Everlasting Valve Co.
	One B & W		Babcock & Wilcox Co.
Atmospheric relief	Multiport		H. S. B.W. Cochrane Corp.

GENERAL DATA

Consulting Engineers: Chas. T. Main, Power House; Stone & Webster, Inc. Boiler Plant. Contractors: Stone & Webster, Inc.

Using Water Injection on Semi-Diesel Engines

The bleeder valve is for the purpose of feeding water into the air port, which water goes into the cylinder along with the air and becomes a part of the explosive mixture.

Don't open this valve until the engine begins to pound or knock regularly at each revolution, and then just enough to stop the pounding and no more.

Don't use any more bleeder water than is absolutely necessary to stop the pounding (intermittent pounding and racing indicates too much bleeder water).

Don't forget that a leaky nozzle, cold cylinder, stiff governor or air in the fuel line and the lack of compression will also cause racing and intermittent pounding.

Open the bleeder valve when throwing on the load, and when starting it if it pounds.

Too much water will cause the engine to miss explosions, run loggy and finally stop.

It is essential that the water pressure through this valve be constant and the feed regular.

Bleeder water lines should have check valves to prevent air blowing back and causing irregular water feed.

Don't fail to close the bleeder valve when engine stops.

Strive to set up conditions that will prevent an excess of bleeder water being used.

The hotter the cylinder jacket water the more bleeder water required.

The greater the load the more bleeder water required.

Don't fail to reduce the bleeder water as the load goes off.

The higher the cylinder compression the more bleeder water required.

Operation of a Traction-Type Elevator-Machine Alternating-Current Motor Controller

By WILLIAM ZEPERNICK

Different parts of a controller for a single-speed alternating-current elevator motor are explained and the circuits traced out through controller and motor for one direction of the machine.

IN A previous article (Feb. 21, 1922) the operation of an alternating-current single-speed elevator controller, for a single-speed drum-type machine was described. However, present-day practice tends toward the traction-type machine. The drum-type machine is necessarily cumbersome, particularly for higher rises, and is subject to the danger of serious accidents caused by the car or counterweight being drawn into the overhead works, due to improper setting of the limits or their failure to function. Such conditions are liable to cause the hoist or counterweight cable to part and may result in a serious accident. The traction-type machine is free from the danger of having the car or counterweights strike the overhead works, since the driving power to the car or counterweights is obtained through traction of the ropes upon the driving sheave. To obtain this traction, the hoisting ropes on each side of the driving sheave must be loaded. In the event that the counterweight or car lands on the bumpers provided in the pit, the load is relieved on one side of the driving sheave and the machine loses traction and prevents either the car or the counterweight from being pulled into the overhead work.

Automatic Limit Switches

With the traction-driven elevator automatic limit switches cannot be used on the machine, since any shifting of the cables on the traction sheave will change the position of the car in the hoistway relative to the time of opening the machine limits. The machine automatics have been replaced by the more reliable hatchway limit switches, either mounted on the car hitch beam and operated by fixed cams in the hatch or mounted in the hatch and operated by a cam mounted on the elevator car. This arrangement provides for a fixed point of operation of the circuits controlled by the hatch automatics, therefore they will always operate at the same distance from the terminal landings regardless of the stretch or slippage of ropes, thus eliminating the frequent adjustments necessary with the machine automatics as is required on drum-type machines.

In the traction-type machine, if the safeties set, the cables will not become slack, therefore means other than a slack cable switch must be provided to stop the motor when the car safeties operate. For this purpose a car-safety operated switch located under the car is used and is connected mechanically so that the action of the safeties in setting will open a contact and cause the direction and potential switches to open. In some cases the substitute for the slack cable switch is placed on the safety governor.

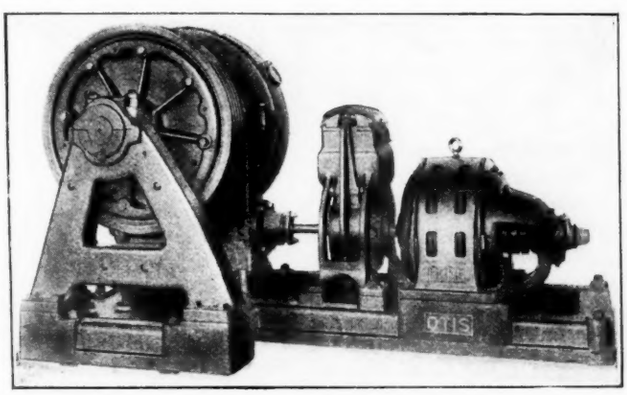


FIG. 1. OTIS SINGLE-WRAP TRACTION ELEVATOR MACHINE

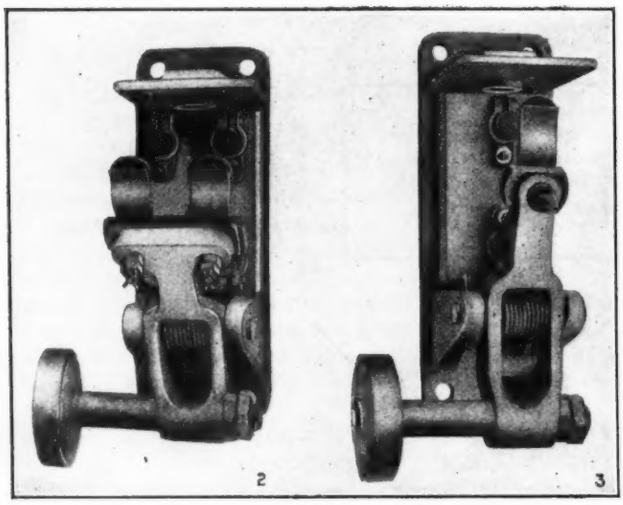
An Otis single-wrap traction-type elevator machine is shown in Fig. 1. This machine is driven by a single-speed slip-ring type motor, and equipped with a magnet brake. The general arrangement of this machine is as compact, accessible and substantial as the direct-current machine. The controller does not differ materially from that used with the drum-type machine. The method of wiring the operating circuits from the controller to the car switch and safety devices differs from that for the drum-type and is considered in subsequent paragraphs.

Limit Switches in Hatchway

To provide stopping of the elevator at the terminals of the travel independently of the operator, hatchway automatics are used. The hatchway automatic in this case consists of a cam mounted upon the car and located so that the limit switches (Figs. 2 and 3) provided at the terminals of travel will be opened. Fig. 2 is a two-pole switch utilized to open two circuits, and Fig. 3 a single-pole switch opening one circuit. Each circuit is opened at two points to provide a positive opening. One each of these limit switches is provided at each terminal landing in the hatch. The first to open is the two-pole switch and the second (final) is the single-pole switch. In the simplified wiring diagram, Fig. 5, the first limit switch to open at the top landing is marked LU_1, the second LU_2.

When approaching the terminal landing at the top the two-pole limit opens LU_1 contacts, releasing the up-direction switch magnet A, which will open contacts A_1 and A_2, and at the same time releases the potential-switch magnet P, which will open contacts P_1 and P_2. When starting, if the potential switch P fails to

operate and close contacts P_1 and P_2, the elevator cannot be started in either direction, since the circuits for the direction magnets are through contacts P_1 and P_2. Should the car slide above the top terminal landing sufficiently to open the single-pole limit LU_2, it will be impossible to obtain a completed circuit through the potential-switch magnet P until the car is lowered



FIGS. 2 AND 3. HATCHWAY LIMIT SWITCHES

either by hand or from the controller, a distance sufficient to permit LU_2 to close. Although the two-pole limit switch on the up motion opens the potential-switch magnet circuit, the circuit is divided through the car switch so that in the opposite direction of travel the circuit to the potential switch can be completed, passing through the two-pole limit switch at the other end of the travel.

Operation of Controller Explained

Fig. 5 is a simplified diagram of the motor and controller, which indicates the condition of the circuits with the main-line switch closed and the car-switch control handle in the center position. Under this condition all circuits are open through the controller. To run the car in the up direction the car-switch handle is moved to the left, as in Fig. 6. The car switch will always be in contact with one of the fingers 13. When the car switch engages contact finger 22, the circuit is completed to the potential-switch magnet coil P, from line L_2 through fuse F_1, gate contact GC to 13 and 22 on the car switch, one pole of top limit switch LU_1, top limit LU_2, door contacts DC, bottom shaft limit LD_2, emergency switch ES, car-safety switch or governor switch SO, potential-switch coil P, fuse F_2 back to the L_3 side of the line. Energizing magnet coil P causes contacts P_1 and P_2 to close and complete the circuit for the up-direction magnet coil A. This circuit is from contact 15 on the car switch through coil A, the other pole of the top limit switch LU_1, fuse F_3 contact P_1 of the potential switch and to the L_4 side of the line. This energizes coil A and causes it to close contacts A_1 and A_2, which completes the motor, brake and accelerating coil L circuits. The brake circuit is from M_2 on the motor through the brake coil, contacts A_2 and P_2 to the L_3 side of the line.

Energizing the brake coil releases the brake and allows the motor to start the machine. There are two circuits through the motor's stator winding, one from M_2 to M_3 through contacts A_3 and P_1 to the L_1 side of the line, while the other circuit is from M_2 to M_1 through contacts A_2 and P_2 to the L_3 side of the line. This causes the motor to start with all the rotor resistance in circuit. Contacts L', M', N' and O' on the rotor resistance are closed by coils L, M, N and O respectively. Coil L is the first to be energized and the circuit is from M_2, through fuse F_4, coil L, contacts A_2 and P_2 to the L_3 side of the line. This causes contactor L' to close and cut out the bottom sections of the rotor resistance.

When contactor L' closes, Fig. 6, it also closes an auxiliary contact l, which completes the circuit through coil M and closes contactor M' and cuts out another section of the rotor resistance. On closing, contactor M closes auxiliary contacts m and completes the circuit through coil N and closes contactor N' and cuts another section of the rotor resistance. When contactor N closes, it also closes auxiliary contact n and completes the circuit through coil O and closes contactor O', cuts the last section of the rotor resistance out and causes the motor to come up to full speed. When contactor O closes, it closes auxiliary contacts 1 and 2 and opens auxiliary contacts 3 and 4. The opening of contacts 3 and 4 immediately releases L and M accelerating magnets, the releasing of accelerating magnet M opens the auxiliary contactor mounted upon it for coil N which also releases, so that when the motor is running at full speed the only contactor closed is O', and this is held closed by coil O through auxiliary contacts shown at 1 and 2.

Comparison of Controllers for Drum and Traction Type of Machines

It will be noted from the foregoing that the operation of the motor, brake and accelerating magnets is identical with the operation explained in the article,

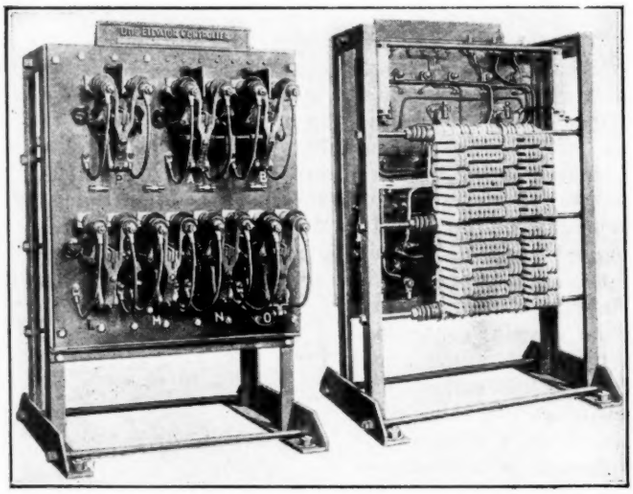


FIG. 4. FRONT AND BACK VIEWS OF OTIS TYPE 2-SS ALTERNATING-CURRENT MAGNET ELEVATOR CONTROLLER

"Operation of a Drum-Type Elevator Machine Alternating-Current Motor Controller" (Feb. 21 issue), with the exception that the main-line current does not pass through the automatic limit contacts as with the drum-type machine. The connections for the accelerating magnets shown in Figs. 5 and 6 are the better arrange-

ment and subject to less trouble. Auxiliary contacts marked *l*, *m* and *n* are mounted on the auxiliary accelerating magnets, *L*, *M* and *N* respectively. The last, or final, accelerating magnet *O* has a make-and-break contact mounted upon it which provides for permitting

For those who wish to do so, the circuits on the simplified diagram, Figs. 5 and 6, can be easily identified on Fig. 7 and traced out in the same way as for Fig. 6. The rotor resistance is not connected, but its terminals are lettered to indicate the way in which they

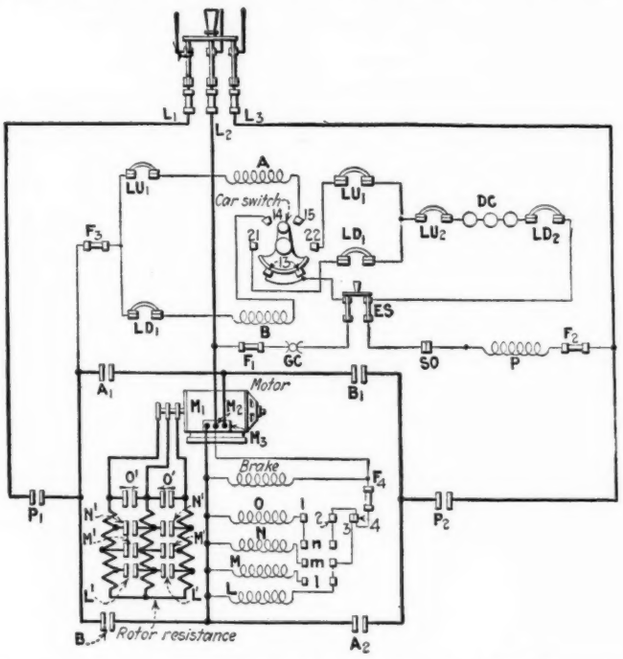


FIG. 5. SIMPLIFIED DIAGRAM OF FIG. 7; CAR SWITCH IN OFF POSITION

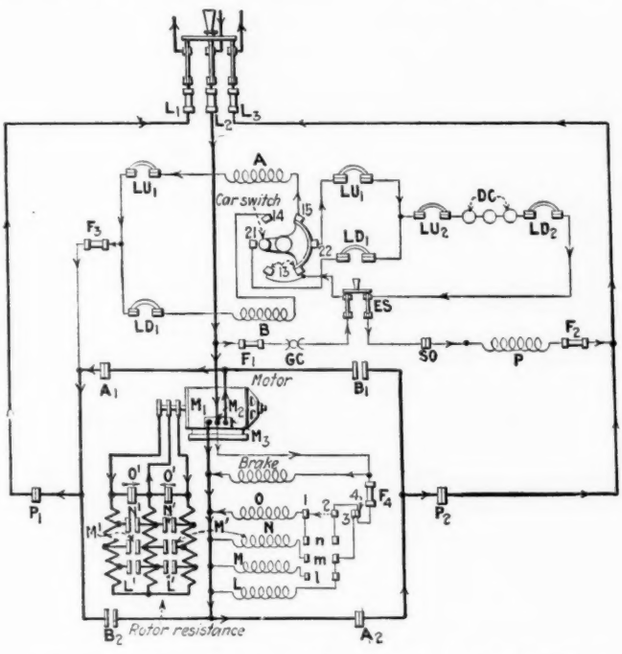


FIG. 6. SIMPLIFIED DIAGRAM OF FIG. 7; CAR SWITCH IN UP POSITION

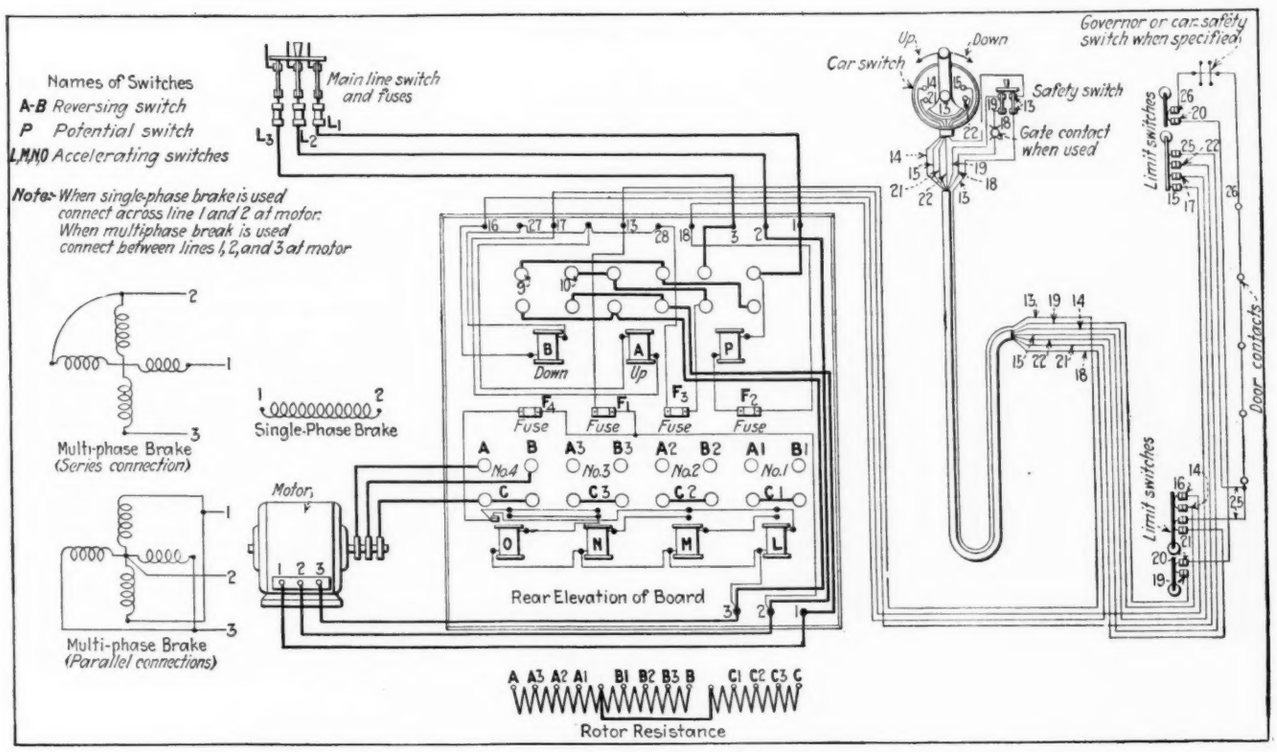


FIG. 7. WIRING DIAGRAM FOR CONTROLLER FIG. 4

magnet *O* to become self-holding, at the same time releasing auxiliary accelerating magnets *L*, *M* and *N* as previously explained.

Fig. 7 is a standard wiring diagram of the control and motor wiring as supplied by the Otis Elevator Co. connect to the contactors. The various contactors on Fig. 7 are also indicated on Fig. 4. It will be noticed that they are in the reverse order on the diagram to what they are on the photograph. This is due to the diagram showing a rear view of the controller.

Burning Boiler Oil in Diesel Engines

By LOUIS R. FORD
Chief Operating Engineer, Worthington Pump and Machinery Corporation

OWNERS and operators of oil engines are interested in the question of cheap oil. Boiler oil sells for one half the price of refined oils. Engineers are inclined to think that this cheap fuel cannot be used in the Diesel. Mr. Ford tells how it may be done and the operating results.

THE rapid development of the Diesel engine in recent years has produced a type of motive power that is coming into general use, especially in small and medium-sized power plants. The manufacturers have recognized that the next logical step in development of the Diesel is its adaptation to the use of the heavier and cheaper grades of fuel oil, known as "boiler oil." This development has been pushed vigorously, and it is now possible for any user or prospective user of Diesel power to utilize the large stocks of relatively cheap boiler fuels.

It has heretofore been considered, in most installations, at least inadvisable to use as fuel for Diesel engines any oil of much less than 30 deg. Bé. or 0.875 specific gravity, and all specifications for such fuel contain very rigid sulphur requirements, the maximum permissible sulphur being 0.5 per cent. This necessitates special treatment in refining, and the oil thus produced is marketed under special trade names, such as Diesel oil, motor oil, etc.

The grade of special fuel oil supplied to the trade for operating Diesel engines is represented by the following characteristic analysis of a random sample at one of the large fueling stations near New York: Gravity, 29.6 Bé.; flash point, 175 deg. F.; sulphur, 0.4 per cent; cold test, 0 deg. F.; viscosity, Saybolt at 100 deg., 200; water, slight trace; heat content, 19,465 B.t.u. Below this grade there are oils of varying gravity, possessing different potentialities for trouble in using, down to crude oil from the Panuco field in Mexico, which is about the most difficult of all to handle at every stage from the wells to the engine cylinders. The most widely distributed fuel available at all stations is the so-called Grade C oil or its equivalent which is the grade normally used for burning under boilers. This oil is the residue after the crude has been treated to extract the gasoline and kerosene. The following is a representative analysis: Gravity, 14 to 16 Bé.; flash point, 150 deg. F.; sulphur, 3-4 per cent; viscosity, Saybolt, at 100 deg. F., 2,000 to 4,000; water and sediment, 1 per cent; heat content, 18,500 B.tu.u.

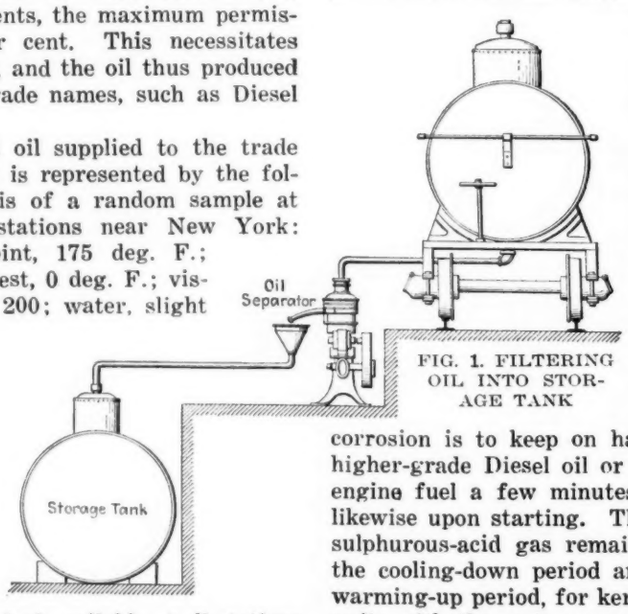


FIG. 1. FILTERING OIL INTO STORAGE TANK

The first problems that arise in connection with the use of the low-grade fuels are those involved in transportation, storage and pumping, due to their high viscosity; and since viscosity is a function of temperature, these problems concern methods of heat application. It should be noted that the relation between Baumé gravity and viscosity is not constant, and two oils from different localities may have the same Bé. gravity, yet vary considerably in viscosity. For this reason the fact that an engine is operating on 16 deg. Bé. fuel oil does not necessarily mean that the same method of treatment would permit operation with another oil of the same gravity. The Bé. gravity does, however, give a rough indication of the suitability of an oil for use as Diesel-engine fuel and the conditioning treatment required.

As indicated by the low sulphur content called for in the specifications for special Diesel fuel, it has been considered that sulphur in the low-grade oils, resulting in the formation of sulphurous-acid gas during combustion, constituted the chief bar to their use. Water vapor is produced by the combustion of the hydrogen in the fuel, and if the exhaust gases are cooled sufficiently to condense this water vapor, it combines with the sulphurous-acid gas and becomes actively corrosive to the metal of the valves and cylinder liners. This condensation cannot occur while the engine is in operation because the exhaust gases leave the cylinders at a temperature of about 600 deg. F., which is much above the condensing temperature of the water vapor. The corrosive effect, then, can be expected only where the engine is stopped and after the gases left in the cylinders and exhaust passages cool to the condensation point. The easiest method of preventing this corrosion is to keep on hand a small quantity of the higher-grade Diesel oil or kerosene and use it for the engine fuel a few minutes before shutting down and likewise upon starting. This eliminates the danger of sulphurous-acid gas remaining in the cylinder during the cooling-down period and its formation during the warming-up period, for kerosene contains no sulphur to unite with the water vapor. This method of operation is desirable for other reasons to be pointed out later.

Practically all the available boiler oils are asphalt-base oils and the principal difficulty in their use arises from the asphalt content, which is much harder to burn than any of the other constituents. If conditions are not right, an engine may operate for a considerable length of time by burning the more easily combustible constituents, leaving the asphaltic residue to collect in the piston-ring slots, on valve stems and in exhaust passages in the form of a tough, elastic gum. This gummy substance is combustible if sufficient heat is supplied, but after it once becomes attached to metal surfaces not directly in the zone of highest heat, the metal carries away the heat so rapidly that a temperature high enough to insure combustion of the gum cannot be attained. It can be removed only by opening up the cylinder and taking out the piston. This means that if operated under the condition just mentioned, the friction load due to the accumulation on the piston

gradually reduces the effective power of the engine and finally forces a shutdown for removal and cleaning of piston and rings.

A cold piston may be removed from its cylinder so gummed up with this residue that the rings are frozen absolutely tight in their slots in the compressed posi-

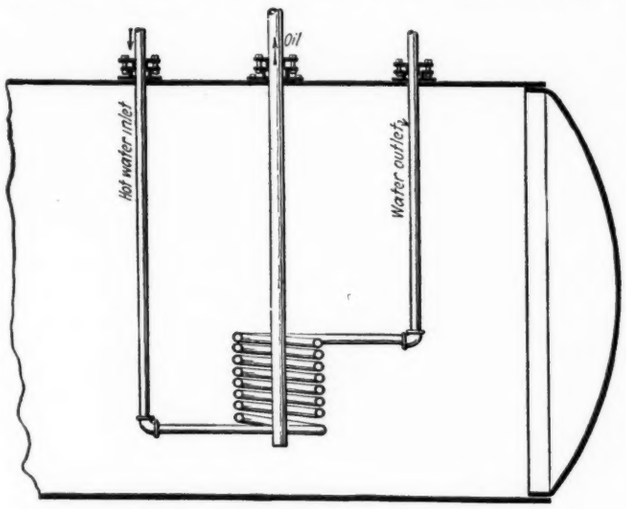


FIG. 2. HEATING COILS IN TANK

tion, but if the piston and rings are heated with a blowtorch, the residue becomes fluid and the rings will spring out to their normal position and can readily be removed. Cases have been known where this tenacious asphaltic gum has accumulated on the piston to such an extent that, with the cylinder head off and the turning gear in operation, the friction between piston and cylinder has been sufficient to push the liner out of the cylinder. In those cases it was noted that all the accumulation was on the sides of the pistons and the piston tops were quite clean. The top is normally the hottest part of the piston and there is sufficient heat to burn all the fuel that may strike the top.

If the cylinders, heads, pistons and valves can be brought to normal working temperature before the fuel is admitted, combustion will be complete and no residue will be deposited. It is practically impossible to heat these parts up to the desired temperature without actual running, and if the engine is started with the heavy fuel, several minutes' running must elapse before the normal running temperature is reached. During this time the unburned part of the fuel is depositing on the exposed metal surfaces, and even after the highest practicable working temperature is reached, this deposit cannot be burned off except from the surfaces within the combustion space. That part of it that reaches the sides of the piston and the piston-ring slots never burns. Every time the engine is started, the accumulation at these points is added to, and finally a condition is reached that makes starting impossible. During the period of incomplete combustion unburned particles of fuel are carried by the exhaust gases, and some of them strike the exposed portion of the exhaust-valve stem every time the valve opens. They accumulate in the clearance space between the valve stem and its guide and eventually cause the stem to stick. The simplest method of preventing these troubles is to start the engine on a light, easily burned fuel oil and operate with this oil until the engine is thoroughly heated, then switch to the heavy oil.

It is highly important, however, to maintain always this high-temperature condition within the cylinders. It is the highly heated compressed air within the combustion space that must be depended upon to burn the asphalt in the fuel. The temperature of this air depends upon two things—the amount it is compressed, or the ratio of its volume after compression to its volume before compression, and its temperature at the beginning of compression. For normal operation with the lighter grades of oil, the clearance space is adjusted to produce a pressure of 480 to 500 lb. of air after compression. To insure complete burning when using heavy oil, this compression pressure should be increased to 500 to 525 lb., and the jacket cooling water should be regulated so that the engine normally runs hotter with heavy fuel than with light. It is usually considered good practice to regulate the cooling water to permit a temperature difference of 60 deg. between inlet and outlet water, but this may be increased to 80 deg. No fixed rule as to water temperature can be given that will be applicable to all engines, but usually the limiting factor is the clearance between cylinder walls and piston. Any jacket-water temperature below the boiling point is permissible if this clearance is sufficient to allow the resulting piston expansion.

Quite as important is the problem of keeping the fuel in a sufficiently fluid state to permit correct atomization in the cylinders and efficient performance of the fuel-measuring pumps. The degree of fineness to which the individual particles of oil are reduced in the atomizing

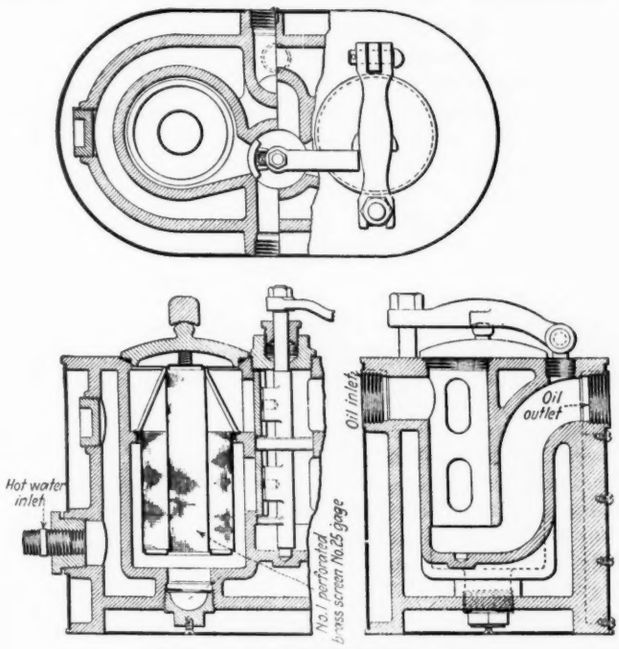


FIG. 3. JACKETED OIL FILTER

process naturally has an influence on the ease of burning, as the more completely the oil is broken up the easier it is for the air and oil to combine. Viscosity has a direct effect on atomization and on the ability of the pumps to handle the oil, but it has been determined experimentally that if the viscosity of any oil is reduced sufficiently to meet the atomization requirements, it will be sufficiently fluid to pass through the pumps. The only practicable method for reducing viscosity is by the application of heat, and the amount of heat required varies with different oils. It is an interesting fact

that in the case of any low-grade fuel oil that may be used in Diesel engines, good atomization and satisfactory combustion can be obtained if the viscosity is reduced to 400 seconds Saybolt. Different oils of the same gravity require heating to different temperatures. Tests on two Grade C oils of the same gravity have shown that in order to reduce the viscosity to 400 sec. it was necessary to heat one to 177 deg. F. and the other to 186.

The necessary heating of the oil can be done economically by utilizing the waste heat in the engine exhaust. In cold climates heating of the oil must begin at the tank cars. All fuel-oil tank cars are equipped with heating coils with an outside connection to which a steam hose can be connected so that the contents of the car can be made sufficiently fluid to permit pumping or gravity flow to the underground storage tanks. The oil should be cleaned, as far as possible, of dirt, etc., before it enters the storage. Fig. 1 outlines one method using a centrifugal separator.

The storage tanks should also be fitted with heating coils. If small service tanks are provided, from which the measuring pumps on the engine are supplied, the oil in the storage tanks is heated only enough to permit handling in the transfer pump, but that in the service tanks must be heated suficiently to reduce it to the required viscosity for injection into the engine. Heating the large body of oil in the storage tanks, where the oil is not changed rapidly, is very effectively accomplished by means of ordinary pipe coils, allowing about one square foot of heating surface to 60 cubic feet of oil, but the coils should be located around or near the pump suction pipe as in Fig. 2. In the small service tank from which the oil is removed at a fairly rapid rate, excessive coil capacity is required in order to heat the oil as fast as it is taken out, and even under the best conditions a steady temperature cannot be maintained. The best arrangement is to heat the oil in the service tanks moderately, then pass it through a pressure heater of the film type on its way to the fuel-measuring pumps on the engine. The oil should now be sufficiently fluid to be forced into the cylinder without additional heating.

A very effective method of utilizing the heat from the engine exhaust (which would otherwise be wasted) to heat the oil, is to place in the exhaust manifold or in the muffler a water heater through which part of the jacket cooling water may be passed after leaving the jackets. The exhaust gases will raise the temperature of this water in the coils to a high degree, and the hot water can then be used instead of steam to heat the oil. Such a system is shown in Fig. 4. Trouble has been experienced in the past due to corrosion of the metal in the coils or tubes, but heaters are now available in which the surfaces exposed to the exhaust gases are sherardized or are made of cast iron to prevent this corrosion. The advantage in using the jacket water in this way lies in the fact that it enters the heating coils at an initial high temperature due to the heat received in the jackets.

The amount of water and gritty dirt to be contended with varies in the different low-grade oils, and it may be necessary to put the fuel through either static or centrifugal filters. This filtering should be done after heating the oil, as the heat assists in the separation of foreign matter from the oil, or the filter may be hot-water jacketed as in Fig. 3.

We may, then, sum up the main difficulties to be encountered in the use of boiler fuel for operating Diesel engines as follows:

1. High heat required to burn the asphaltic residue.
2. Production of sulphurous-acid gas in the cylinders with tendency to corrode valve seats.
3. Viscosity of fuel must be reduced to permit handling with pumps and produce proper atomization in cylinders.
4. A great deal more responsibility is placed on the operator by reason of the shutdowns that may be caused by clogging of valves, deposits in cylinders, sticking of piston rings, etc., that may occur if operating conditions are not kept right.

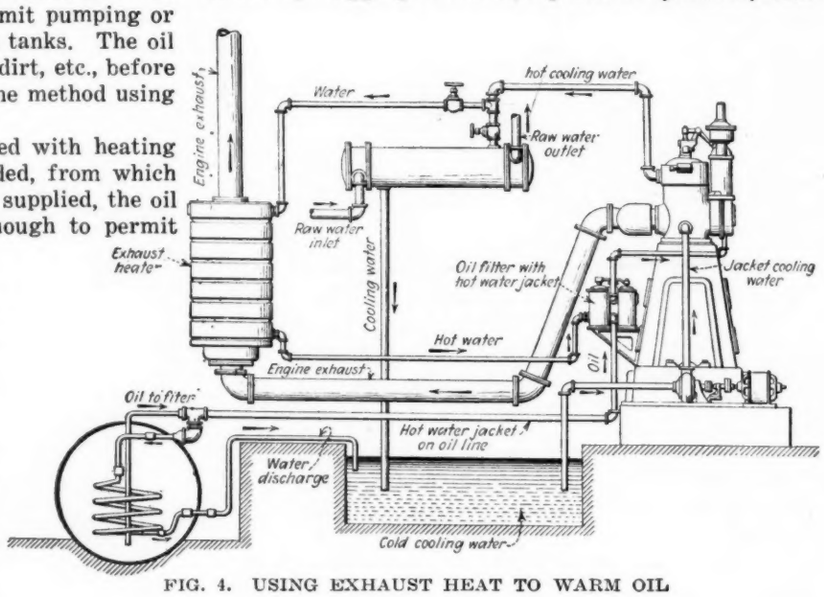


FIG. 4. USING EXHAUST HEAT TO WARM OIL

The difficulties outlined in this discussion may be overcome in the following way:

1. Starting the engine on light oil and shifting to the heavy after the engine is hot, maintaining high compression and regulating the jacket-water temperature to insure a higher compression.
2. Shifting to light oil a short time before shutting down so that all sulphurous-acid gas will be cleared out of engine before exhaust gases cool enough to condense the water vapor.
3. Installation of steam or hot-water heaters and heating the oil to the temperature required to reduce it to 400 seconds Saybolt viscosity.
4. Hiring engineers of intelligence and giving them proper instruction in the ways in which operating conditions with heavy oil vary from conditions with light oil.

In conclusion it may be stated that so much progress has been made in the adaptation of the Diesel engine to operation with cheap fuels that any prospective user will have no difficulty in securing co-operation from responsible Diesel-engine manufacturers in laying out and equipping plants for such service and obtaining expert advice in connection with special or local conditions.

The cheapness of the boiler oil compared with the high-grade fuels more than justifies the slight increase in maintenance and care required.

Finding a Suitable Lubricating Oil For a Circulating System

By W. F. OSBORNE
Supervisor Manufacturers' Service, Texas Company

AFTER the correct viscosity has been determined and temperature tests have shown that a minimum amount of friction is being developed, it remains to be considered whether the oil is suitable for the particular type of oiling system, whether it will deteriorate too rapidly and whether the consumption of oil will be sufficiently low.

All types of circulatory systems are not equally good, and the conditions under which the oil has to work are not always the same. Sometimes the unsuitability of an oil will show up almost at once when it emulsifies in a system containing considerable moisture in circulation, but when the oil is suitable it may last a long time without any particular difficulty appearing. A *friction test* can be made in a few hours; a *suitability test* sometimes requires months before a definite conclusion can be reached.

In making such a test, the system first should be thoroughly cleaned, all deposits and sediment removed and washed out with a quantity of the same oil that is to be used on the test. The proper quantity is then put into the system, and the filters and separators adjusted to take care of the foreign matter. Since the life of the oil is largely dependent upon the efficiency of the cleaning apparatus, its operation should be carefully checked.

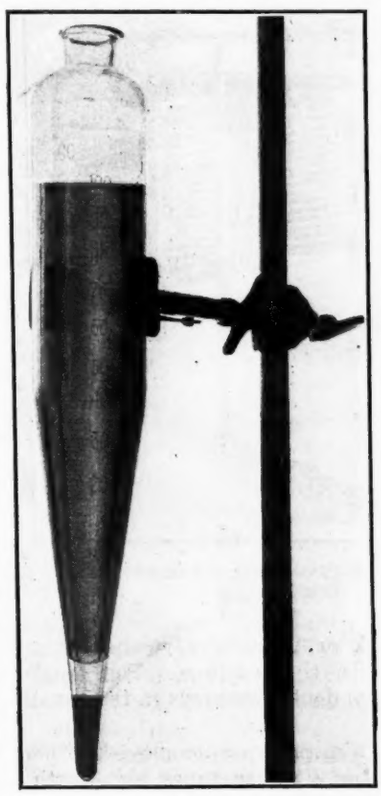
A good way to check up the condition of the oil in the system as compared with the physical properties of the new oil is to take samples at regular intervals, as often as may be necessary, and have them analyzed. The condition of the oil can be determined satisfactorily by taking one sample from the oil line going to the bearings after the system has been in complete operation and thoroughly warmed up for some time. If the samples are taken too soon after starting up the machine, the oil is likely to be in a better condition than normal, as most of the moisture and sediment will have settled out while the machine was idle.

In addition to the sample for complete analysis, it is a good idea to take samples once a week to check up the operation of the filtering and separating apparatus. These samples are taken only for the purpose of finding out the percentage of water and sediment in the oil as it is delivered to the bearings. One way of doing it is to fill a four-ounce bottle and set it away in a warm place for forty-eight hours. At the end of this time the sediment can be seen in the bottom of the bottle.

A better way is to use a regular precipitation tube such as that shown in the illustration, which can be secured from any reliable instrument maker for a couple of dollars. The test is made by putting 50 c.c. of the oil in the tube, adding the same amount of high-gravity gasoline, shaking the mixture thoroughly and allowing it to stand for twenty-four hours. The sediment, moisture and emulsion will settle to the bottom, and the percentage of each can be readily determined. This is a simple test to make and, if regularly carried out, is quite valuable in checking up the operation of the cleaning apparatus.

If it should be found at any time that a considerable quantity of water, emulsion or sediment is being carried to the bearings by the oil, a series of samples should be taken from different parts of the system and the amount of sediment in each compared, in order to locate the point where the trouble is occurring. For instance, a complete set of samples for a steam-engine system having the filter-cloth type of cleaning apparatus, would consist of a sample of oil going from the engine to the drain tank, a sample of oil going to the water separator, one leaving the separator for the filter, one coming from the filter and one from the oil going to the engine bearings. If the sample of oil leaving the separator contains moisture, there is either something wrong with the separator or the quantity of water contained in the oil is greater than the separator can handle. Should the oil going to the engine contain more moisture or sediment than the oil leaving the filter, the storage tank should receive attention.

When the quantity of emulsion or water in the oil going to the separator is serious, it is a good plan to take samples from the drain lines at several points, to locate the exact source of the water. On a steam engine, it might be due to excessive moisture in the steam leaking past the piston-rod stuffing boxes, and a considerable amount of emulsion might be caused by a compounded steam cylinder oil coming over with the condensed steam. With a little experience any engineer can check the condition of the oil in a circulatory system very closely. Of course it must be remembered that this method does not show anything about the physical characteristics of the oil itself, which can be checked only by laboratory analysis. Once in three months, or in severe cases once a month, a complete analysis of the oil should be made. The frequency depends a good deal upon the quantity of fresh oil added to the system as makeup oil, and the quantity of oil in the system. The makeup oil should be added at frequent intervals in small quantities



TESTING OIL FOR FOREIGN MATTER

rather than at long intervals in larger quantities. The first method will maintain the oil in better condition, evaporation losses will be lower, the deterioration of the oil in service will be less and the strain on the cleaning apparatus will not be so severe. It is much better to add ten gallons a week than one barrel a month.

The consumption of oil in a circulatory system cannot be checked in a short time, and the comparative suitability of two oils in this respect frequently requires many months of continuous service before a definite decision can be reached. There are so many factors affecting the consumption that average conditions over a long period of time are necessary in order to secure a fair comparison.

Page Cross-Drum Water-Tube Boiler

A new cross-drum water-tube boiler having a number of refinements in design has been brought out recently by the Page Boiler Co., of Chicago. As shown in the illustrations, it is of sectional construction, so that it may be shipped knocked down; by varying the number of sections it may be made, within limitations, in any capacity from 1,500 sq.ft. up.

An outstanding feature is the arrangement of the water circulation. Double curved tubes lead from the bottom of the drum to the top of each rear header, which is curved back slightly to receive the tubes at right angles. This construction avoids a dead space in the bottom of the drum, and as the curved tubes give a flexible connection, taking care of expansion and contraction, the rear headers are relieved of the weight of the drum, which is supported separately by structural steel, a new feature in this type of boiler. The headers themselves rest on a 10-in. mud drum, which is supported by structural work or by saddles resting on a brick pier, as indicated in the halftone. The front headers are suspended from double channels in the usual manner.

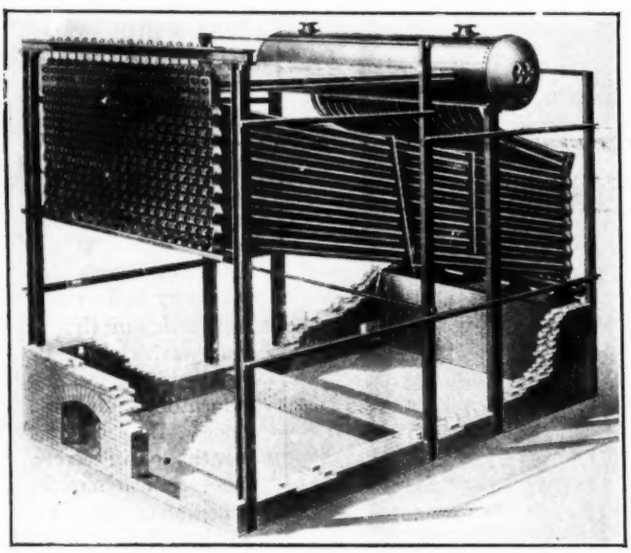


FIG. 1. METHOD OF SUPPORTING PAGE CROSS-DRUM BOILER

Throughout the boiler 3-in. tubes are employed. The sections are made fifteen or eighteen tubes high, with a pitch of 3½ in. to the foot. The headers are of cast steel, with large water spaces. The serpentine construction permits staggering of the tubes, so that straight inclined passages are provided between them; this incidentally facilitates the work of the soot blower. To eliminate gasket and ground-joint troubles, key caps are used throughout except at the bottom of the header opposite the lower row of tubes, where master handhole plates in which the joint is made with a brass bushing are used.

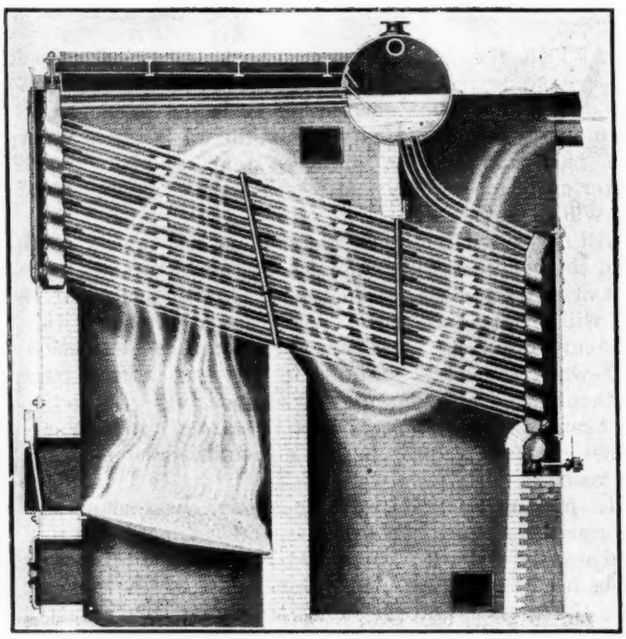


FIG. 2. SECTIONAL ELEVATION THROUGH BOILER SETTING

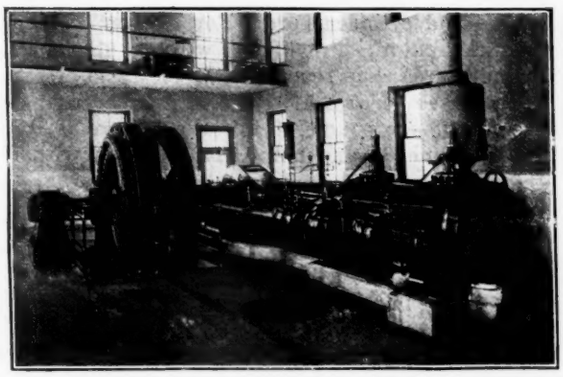
Another feature, although not new with this boiler, is the use of double liberating tubes from each header to the drum. This construction permits high tube sections and, with a tube pitch ½ in. greater than standard, insures good circulation and high capacity per square foot of floor space occupied. The steam discharges at the water line in the drum, so that it is not forced to pass through the body of the water in the boiler.

A new system of double baffling is provided to guide the moisture downward and direct dry steam to the outlet. Upon striking the first baffle, the water passes downward and the steam rises through a 2-in. opening between the top of the baffle and the shell of the drum. The upper baffle prevents the steam from "hugging" the shell and, by changing the direction of flow, separates the entrained moisture that may have been carried up with the steam.

A flat arch made up of structural steel and firebrick forms the boiler top. Transverse I-beams with tee-irons between make up the forms for the firebrick. This construction gives easy access to the boiler and facilitates repairs, two features of considerable importance in the operation of a boiler.

Gasoline production in April, the latest figures available, amounted to 472,920,000 gal. and sets another new high record. Stocks of gasoline also increased nearly 40,000,000 gal. in April, breaking the high records established in each of the two preceding months. Stocks are now nearly 100,000,000 gal. greater than any record made before the first of this year. Consumption amounted to 385,564,000 gal. in April.

Why Engines Are Compounded



AS THIS discussion points out, compounding is in the interest of economy and not increased power. A simple engine with a cylinder volume equal to the volume of the low-pressure cylinder of a compound engine will give the same horsepower as the compound.

IN THE usual single-cylinder steam engine it has been found that there is little advantage in making the number of expansions greater than 5. If a larger ratio is used, the loss from cylinder condensation more than offsets the increased efficiency obtained by the greater expansion. For example, if the initial expansion is 150 lb. absolute (135 lb. gage) with a ratio of 5, the final pressure at *C*, Fig. 1, becomes 30 lb. absolute. The initial temperature (assuming saturated steam) is 358.5 deg. F.; at *C*, with 30 lb. pressure the temperature is 250.4, or a temperature drop of 108.1 deg. Increasing the expansion ratio to 12 by cutting off at *B'*, the final pressure at *C'* is 150 ÷ 12 = 12.5 lb. and the temperature is 208 deg. F., giving a temperature drop of 156 deg. This increased temperature drop during expansion involves a greater loss of heat.

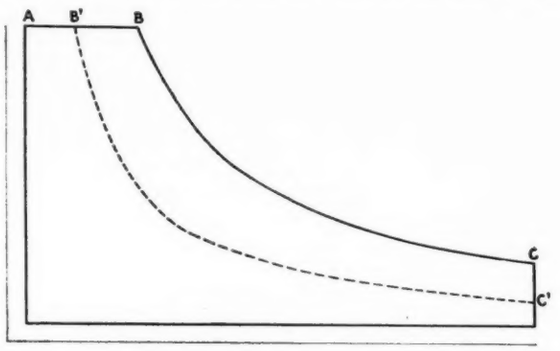


FIG. 1. DIAGRAM SHOWING 5 AND 12 EXPANSIONS

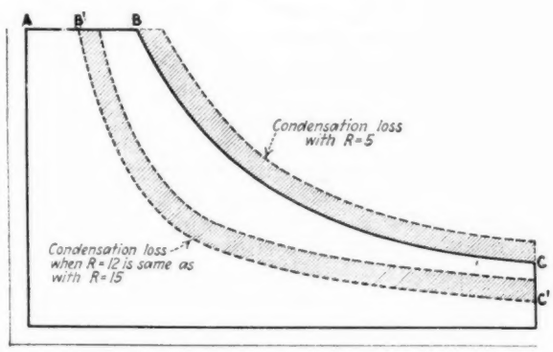


FIG. 2. CONDENSATION LOSS IN THE CYLINDER

A more decisive reason that a large expansion ratio is inadvisable in a single cylinder is that with a given initial and a given back pressure the initial condensation loss is practically constant. If with 5 expansions the loss is 10 per cent of the steam feed, then with 12 expansions the loss will be $\frac{12 \times 10}{5} = 24$ per cent of the steam feed, as indicated in Fig. 2. It will be observed that lengthening the cutoff to one-half stroke would reduce the percentage of condensation loss to 4 per cent, but the small expansion ratio of 2 would give a high pressure at *C*, in this case 75 lb. absolute. This involves a loss greater than the decrease in initial condensation.

If the back pressure is raised so that it is not 26 in. vacuum as in Fig. 1, but 15 lb. gage (30 lb. absolute), the back-pressure temperature becomes 250.2 deg. instead of 126 deg. with 26 in. of vacuum. The loss due to cylinder condensation is decreased by the raising of the back pressure. But if the steam was allowed to pass out of the cylinder at this pressure without doing more work, the loss from the unrecovered energy at release would be large.

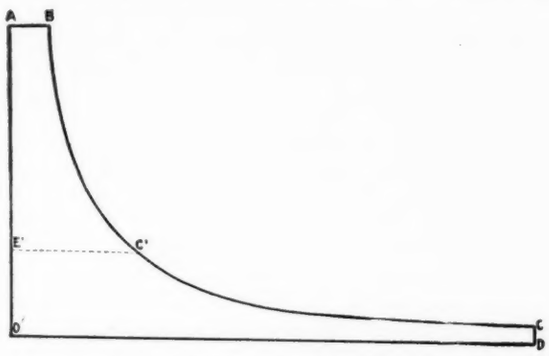


FIG. 3. DIVIDING EXPANSION LINE

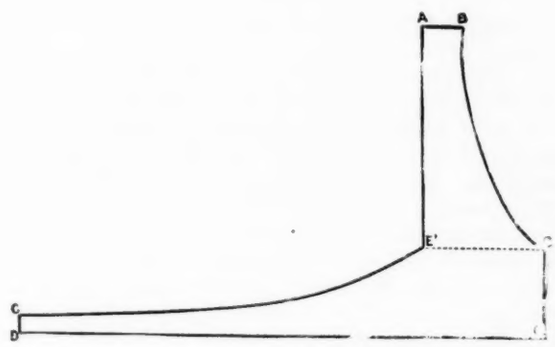


FIG. 4. DIAGRAMS OF TWO CYLINDER EXPANSIONS

Mechanical considerations likewise limit the number of expansions possible in a single cylinder. The weight and dimensions of an engine depend upon the piston

stroke and cylinder bore. For a given horsepower at one-fifth cutoff, a cylinder with a stroke S and a cylinder area A is required. If the ratio of expansions is increased to, say, 10, then with 3 per cent clearance the m.e.p. per pound of initial pressure is 0.369 (see *Power*, June 6) and not 0.5449 as it is with one-fifth

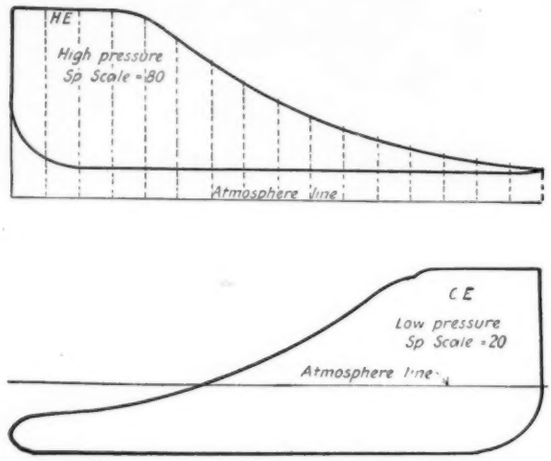


FIG. 5. ACTUAL DIAGRAMS FROM COMPOUND ENGINE

cutoff. To deliver the same power the piston area must be increased by the ratios of the mean effective pressures, or $\frac{0.5449}{0.369} = 1.48$.

If the cylinder diameter is so increased, the pressures on the crankpins, shaft and bearings are increased in like ratio. In addition the cylinder walls must be made thicker since the total pressure has been increased by the ratio of the cylinder cross-sectional areas, or in this case by 1.48. The enlarged dimensions increase the frictional losses. On the other hand, to obtain the horsepower with the same cylinder diameter, the piston speed must necessarily be increased by the ratio of 1.48 to 1. A still further mechanical disadvantage is the large pressure variation during the stroke, requiring more weight in the flywheel, which in turn means a stronger shaft.

To avoid these thermal and mechanical disadvantages and at the same time obtain the increased efficiency that goes with large expansion ratio, compounding, or the expansion of the steam in successive cylinders is resorted to. If the high expansion-ratio diagram of the single engine, Fig. 3, has its expansion line BC divided at C' into two parts, that portion of the diagram $ABC'E'$ may be carried out in a high-pressure cylinder while $E'C'CDO$ may be the diagram of the low-pressure cylinder. In the actual engine the steam will be forced out of the high-pressure cylinder as indicated by $C'E'$ and the low-pressure cylinder will at the same time receive this steam along the steam line $C'E'$, giving the diagrams as in Fig. 4, which is the same as Fig. 3 except that in Fig. 3 the low-pressure diagram has been reversed to make one continuous expansion line.

Since the diagram lengths represent stroke volumes, it would be possible to have a common piston travel for the two cylinders and, by using a large low-pressure piston, secure any stroke volume ratio $\frac{OD}{E'C'}$ that is desired. This may be illustrated by a 30-in. stroke engine. If the high-pressure cylinder be 10 in. in diameter, by making the low-pressure cylinder 20 in. in diameter the stroke volume ratios are as the squares of the diameters, $\frac{100}{400}$, or 1 to 4. If the high-pressure cylinder cut-off at B is at one-third stroke or one-third of $E'C'$, then the expansion ratio becomes the number of expansions in the high-pressure cylinder times the cylinder ratio, or $3 \times 4 = 12$. If the initial pressure is 150 lb. absolute, the final pressure at the end of the low-pressure stroke is $\frac{1}{12} \times 150 = 12.5$ lb. absolute.

The diagrams in Figs. 3 and 4 represent ideal conditions, and diagrams of service engines are quite dissimilar in appearance. Diagrams from both high and low-pressure cylinders are usually taken with the same reducing motion, making the diagram lengths the same for both cylinders, although an indicator spring must be used corresponding to the pressures carried in the respective cylinders. Two such diagrams are shown in Fig. 5. Here the head-end high-pressure diagram is shown with the crank-end low-pressure diagram. This is for the reason that in a tandem compound engine the

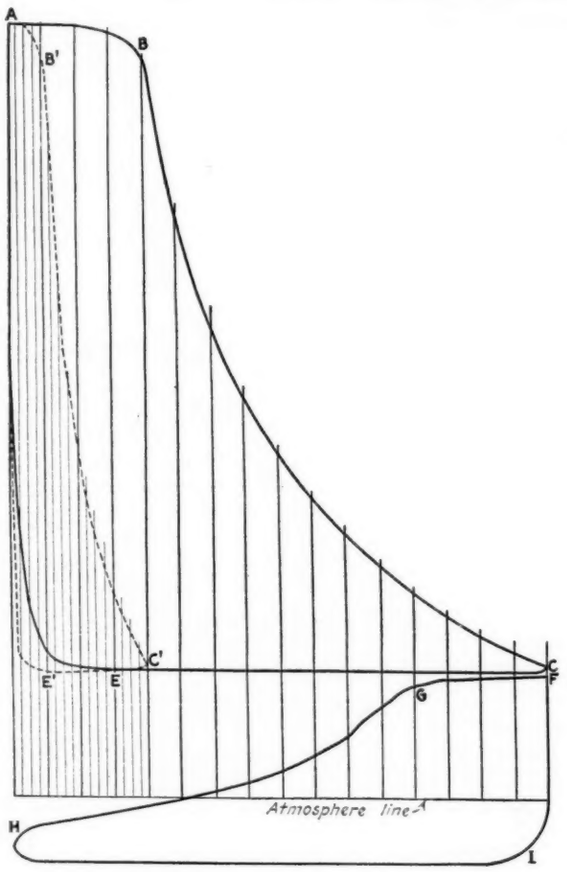


FIG. 6. CORRECTING SPRING SCALE

steam from the head end of the high-pressure cylinder enters the crank end of the low-pressure cylinder, as shown in Fig. 4.

It is highly desirable that the diagrams be transformed to the same pressure and volume scale. To do this the high-pressure diagram is increased in height to correct for the difference with pressure scales. For example, the high-pressure spring scale is 80 lb., while that used when the low-pressure diagram was taken was 20 lb. To put both diagrams on the same basis, the

height of the high-pressure diagram at all points must be increased $\frac{80}{20} = 4$. This is easily done by passing vertical lines through the diagram at ½-in. intervals, Fig. 5. The height of the diagram above the atmospheric line at each point cut by a line is measured and

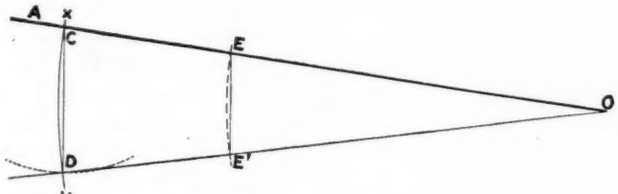


FIG. 7. GRAPHIC METHOD OF CORRECTING FOR VOLUME RATIO

multiplied by 4. This distance is laid out from the atmospheric line on a new sheet of paper, preferably cross-section paper. This gives the high-pressure diagrams *ABCE* in Fig. 6, while the low-pressure diagram remains as it was.

Correcting Diagram for Volume

The high- and low-pressure diagrams now have a common spring scale, but if the diagram lengths are to represent volume a volume correction must be made. This is done in the same manner as outlined for the pressure save that the volume measurements are divided by the cylinder ratios, giving *AB'C'E*, Fig. 5, while the low-pressure diagrams remain as *FGHI*. As example, in a 15 x 30 x 30 engine the volume ratio is the ratio of the squares of the diameters, or $\frac{24^2}{12^2} = 4$. If the ratio is a whole number the high pressure diagram length may be decreased by erecting four vertical lines in each half-inch space as shown and transferring the points cut by one of the ½-in. lines to the corresponding ⅛-in. line. If a large diagram is desirable, the length of the high-pressure diagram may be left as it is while the low-pressure length is increased by the ratio of the two cylinder volumes. In case the cylinder ratio is not a whole number, as 2, 3 or 4, but a fraction, as 3¼, the system of lines in Fig. 5 cannot be applied and each measurement must be multiplied or divided, as the case may be, by the ratio. To avoid dividing each individual measurement by the cylinder ratio, a triangular scale, as shown in Fig. 7, may be constructed. First a straight

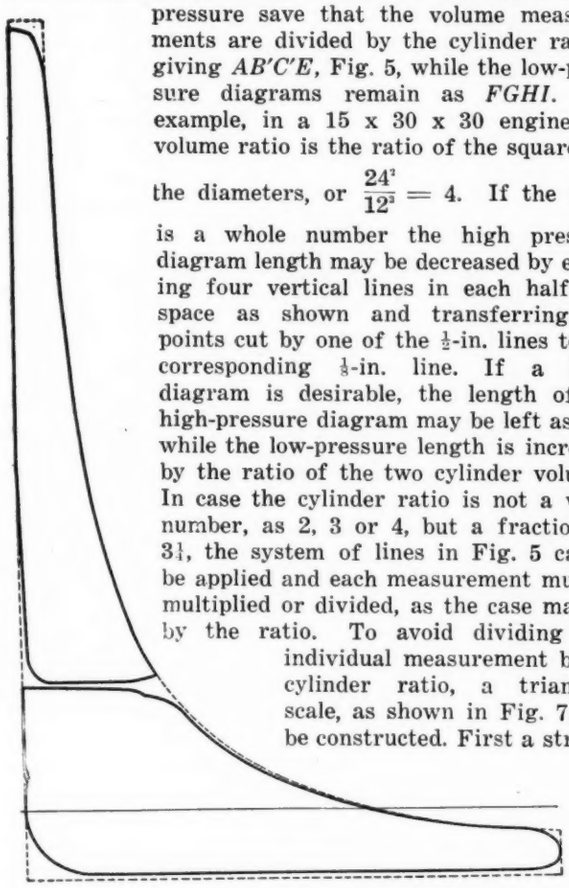


FIG. 8. COMBINED DIAGRAMS WITHOUT CLEARANCE

line *OA* is drawn, and with *O* as the center an arc *xy* with a radius equal to the diagram length is struck. With *C* as a center and a radius equal to *OC* divided by the cylinder ratio, an arc is struck intersecting *xy* at *D*. In this case the ratio is 4, making $CD = \frac{1}{4}OC$. A line is drawn from *O* through *D* and a chord from *C* to *D*, as shown. We have a triangle with two sides *OC* and *OD* equal, while the third side *CD* is equal to $\frac{1}{4}OC$, or $\frac{OC}{CD}$, the cylinder ratio. If any length on the low-pressure diagram, as *OE*, is laid out along *OC* and *OD*, giving *OE* and *OE'*, the distance *E'E''* is the length to be laid out in reconstructing the diagram. This same triangle may be used in correcting the high-pressure diagram for the spring scale. After making these pressure and volume corrections, the combined diagrams, without clearance, appear in Fig. 8.

This discussion has disregarded clearance, but in combining actual diagrams the clearances must be taken into consideration. After the high-pressure diagram is corrected for volume and pressure, as shown, a zero clearance line *A*, Fig. 9, should be drawn at a distance from the left-hand side, such that $\frac{cd}{de}$ = per cent of clearance. The low-pressure diagram should then be placed at a distance from *AO* such that *ab* is equal to the clearance percentage as expressed by $\frac{ab}{bf}$. The diagrams so reconstructed are shown in Fig. 9.

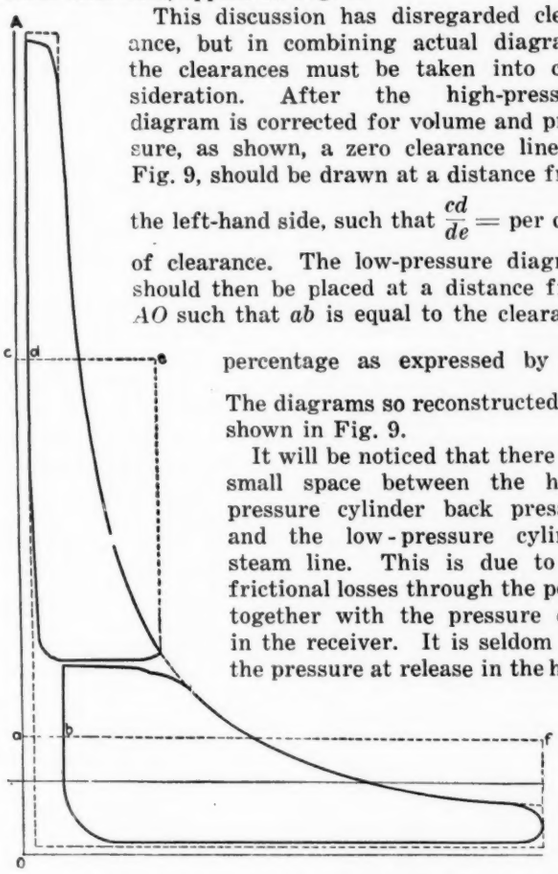


FIG. 9. COMBINED DIAGRAMS AFTER CORRECTING FOR CLEARANCE

It will be noticed that there is a small space between the high-pressure cylinder back pressure and the low-pressure cylinder steam line. This is due to the frictional losses through the ports, together with the pressure drop in the receiver. It is seldom that the pressure at release in the high-pressure cylinder is equal to the receiver pressure. In addition no matter what size receiver may be used, the opening of the low-pressure steam valve draws an amount of steam that will lower the receiver pressure to some degree. This apparent loss is by no means large for, to offset the loss, there is a slight gain in the improved quality of the steam, resulting from the pressure drop without decrease in heat content from the high-pressure release to the low-pressure admission pressure.

Tests for the critical temperature of Freeport coal in different sizes, made at Pittsburgh, Pa., by the United States Bureau of Mines, show that the smaller the size the lower is the temperature at which spontaneous heating begins. Experiments are under way to determine the heat conductivity of coal or rate of dissipating heat through a layer of coal.

Lawrence Oil Engine

In the Diesel and semi-Diesel engines the charge of fuel is injected into the mass of air confined within the clearance or combustion space ahead of the piston. It is a physical impossibility for the oil to contact with each individual portion of the air, and as a result combustion is not as good as it should be. In addition a large excess of air is required in order that sufficient air can mix with the fuel charge.

A second serious fault of the internal-combustion engine is its inability to carry much of an overload even for a short time, for the amount of air drawn into the cylinder during each suction stroke will support only a small excess over the full-load oil requirement. On low loads all of the air is not burned, but is rejected from the cylinder along with the burnt portions. The work of compression, or most of it, is returned during the expansion stroke, but the engine operates inefficiently at low loads due to the mechanical losses.

An engine designed to eliminate some of these objections has been built by P. A. Lawrence, Grand Island, Neb., and for such service as tractor or truck work the unit should show a considerable improvement over the usual oil engines.

A cross-section of the engine cylinder appears in Fig. 1. The cylinder is provided with the usual air and exhaust valves, located in the tee portion of the head. The piston draws in a charge of air, and on the upstroke this air is compressed until the cylinder pressure overcomes the resistance of the spring-loaded air-chamber valve. Whereupon the further upward motion of the piston forces the air through the valve into the air chamber located in the cylinder head.

As soon as the piston reverses and starts downward, a cam strikes the pump-plunger push rod. The pump

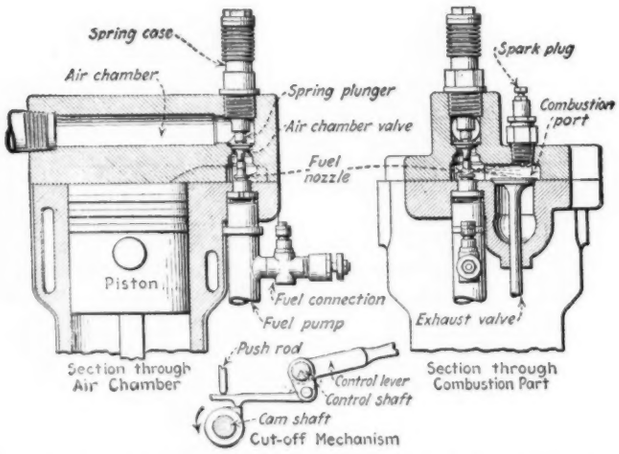


FIG. 1. CROSS-SECTION OF LAWRENCE OIL ENGINE

plunger has two diameters, and an extension enters the air pump immediately below the air-chamber, or transfer, valve. The cam forces the pump plunger upward, causing the fuel to be injected through a hole in the plunger extension, and at the same time the plunger strikes the transfer valve, opening it, allowing the air to flow back into the cylinder, where it mixes with the oil spraying out of the nozzle. To start the engine, gasoline is used and the ignition is secured by a spark plug until the engine becomes heated.

The travel of the pump plunger is regulated according to the load, and in turn the pump-plunger travel controls the length of time the transfer valve is open. If the load is low, the transfer valve is held open during a shorter part of the piston stroke and a small amount of air flows back through the valve. The combustion pressure is controlled by means of a bypass fuel valve

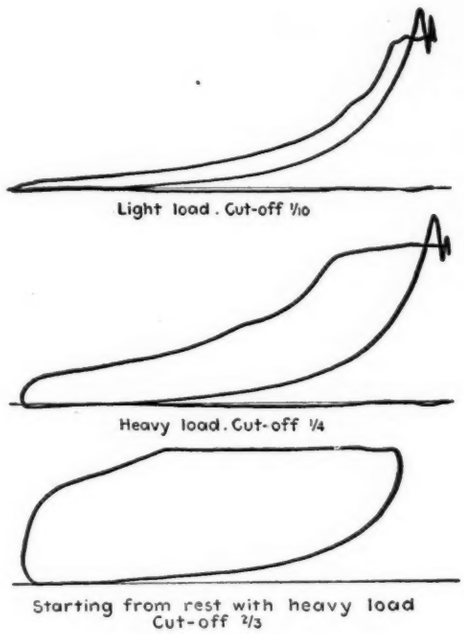


FIG. 2. INDICATOR DIAGRAMS AT VARIOUS LOADS SHOWING LARGE RESERVE POWER

which allows part of the oil to spill back to the fuel suction chamber whenever the cylinder pressure rises above a predetermined value.

A receiver is connected to the air chamber providing a storage for the air not actually required by the load conditions. On heavy loads this stored air flows back into the working cylinder.

In Fig. 2 are shown indicator diagrams for three load conditions. The diagram with two-thirds cutoff reveals the tremendous power reserve possessed by the engine. This should be of advantage in truck service when a hill is reached or for starting from a standstill. Opparently, the excess-air receiver can be made of any capacity, and since the automotive engine ordinarlly operates at a low load factor, a large store of air could be put into the receiver to be used later as may be required.

Since this air flows back through the air chamber, which is uncooled, the air temperature would be raised high enough to support combustion. The air first entering the cylinder is the air last compressed and would no doubt be hot enough to start combustion. Any combustion pressure desired may be carried and in the engine as built the pressure is around 500 lb. per square inch.

The House has passed a bill extending from ten to fifty years leases for the sale of surplus power which may be developed on the Salt River irrigation project in Arizona. Provision is made that the charges for the power may be readjusted at the end of five-, ten- or twenty-year periods.

EDITORIALS

The Cost of Corrosion

CORROSION may be considered as a malignant disease that has fastened itself upon our modern civilization, and for which up to the present time no cure has been discovered. In fact, corrosion in its various forms is so common that it is accepted by the average individual as inevitable without counting the cost of the destruction from this source. However, one of the world's foremost authorities has attempted to estimate the cost, and the sum total is staggering.

In a paper on "The Corrosion of Ferrous Metals," by Sir Robert Hadfield, presented recently before the Institution of Civil Engineers, the author estimates that the loss to the world from rust in 1920 was twenty-nine million tons of steel at a cost of approximately three and one half billion dollars. Although these figures are only an estimate, no one is better equipped to make this estimate than Sir Robert, and for this reason they are significant. One has only to stop and think of the effects of the rust that is going on every day in our power plants, railways, steamships, everywhere all over the world, in industry and out, to see that this estimate is probably conservative.

If the loss due to corrosion of other metals is added, the annual cost to the world is probably not much short of the five billion dollar mark. The exact causes of corrosion and methods of preventing it are questions that are open to discussion. In fact, it may be said that we are still in the dark. However, if scientists properly fitted to deal with the problem were financed to the extent of only a small fraction of one per cent of the annual cost of corrosion, it undoubtedly would be one of the quickest ways of relieving humanity of this tremendous burden, if there is such a thing as relief.

First Come, First Served

THE Supreme Court of the United States has decided the case of Wyoming versus Colorado in the matter of the diversion of water from interstate rivers. The decision says, in effect, that the first one to appropriate water rights for practical use is entitled to full protection even though that water may have originated outside the state in which it is used. Thus the decision is against the State of Colorado, which desired to divert to use within its boundaries water originating there which was required on the lower river for completed developments within the State of Wyoming.

The decision does not directly concern the pending plans of the Colorado River Commission, but it inevitably will affect the proceedings of that body. In fact, the decision greatly simplifies the work of the Commission since it makes clear that any development on the lower portion of the river, once it is properly undertaken, will be protected against diversion of the water at points above which may lie within the State of Colorado. Thus it seems to be evident that Colorado will have to co-operate at an early date with the Commission, which it has failed to do thus far. Otherwise, it may lose forever the opportunity to participate in the plans for and utilization of the power that will be available from the stream.

The progressive spirit that inspires prompt industrial application of the water-power resources should be thus encouraged. Without this assurance of permanent water rights, no matter how progressive one might be he could not venture full development if someone upstream were free to turn the water from its channels and leave him with a power plant but no water. It is fortunate that the law has been so framed and is so interpreted by the Supreme Court. The decision will do much to stabilize development, as well as to settle the particular problems herein referred to, affecting the State of Colorado in its relation with Wyoming and with other states that are interested in the lower Colorado River.

A National Hydraulic Laboratory

IT IS proposed to establish in Washington a National Hydraulic Laboratory. The purpose of this institution would be systematic research and study of flood-control problems on the streams of the United States. The proposal is incorporated in a joint resolution of Congress which has been introduced in both Houses by members of the Louisiana State delegation.

This is a splendid idea and one that should be of interest to power-plant engineers as well as to those concerned more directly with the flood control. That there is need of information that such a laboratory could develop is all too evident from the disastrous consequences of the flood conditions that have prevailed during recent months on the lower Mississippi. Practice in hydraulic engineering has not been supported by adequate knowledge either as to the properties of water flow or the best means of levee construction; and even the knowledge that we have has not been adequately applied, for John R. Freeman, the eminent authority in this field, estimates that in some cases the factor of safety used in construction has been as low as 1.05. As a matter of fact one might even suspect from recent events that the factor of safety in some construction has been 0.95 or even less.

It would seem that one of the conspicuous developments from research in this field would be evidence in favor of greater water storage in rivers on which water-power development is to be made. This phase of the subject will interest the power-plant engineer particularly. If such results can follow from research, there will then be added impetus to adequate power development on many of the streams that are now regarded with little favor because of the wide fluctuations in flow.

The largest item in water-power cost is the capital charge on the investment. If there is some way in which durable dams and power houses may be had at lower cost because of greater skill in their design, this, too, will be a welcome contribution to the industry. Altogether there is great opportunity in this field.

Ordinary Occurrence Utilized as Fatigue-Testing Phenomenon

THE small boy breaks a piece of wire by repeated bending at one point. The wire becomes hot, making his task more difficult; it is evident also that more force is required to bend the wire, and sometimes it is impossible for him to continue to bend it at this point on account of increased stiffness.

The fatigue and breaking of materials under repeated stresses has recently been brought into the realm of tests and calculations. Heating that occurs during fatigue stress is the critical point in determining the fatigue limits, so that the painful observation of the small boy is now a subject of absorbing interest to trained scientists.

A report of an investigation of this subject was published by the University of Illinois within the last two years, and an article by C. E. Stromeyer, of England, one of the pioneers of this field, was recently presented. This states that a factor of safety is in reality a factor of ignorance and suggests that in the future one may have means of calculating the absolute factor of safety for known fatigue conditions.

From the fact that the ultimate strength is increased, or, in other words, the material is actually made stronger by fatigue stresses, it would occur to the reader of Mr. Stromeyer's paper that fatigue treatment may some day be a paying commercial process for increasing the usefulness of metallic substances.

Many happenings that now pass unnoticed, many "kinks" in accomplishing things known to the practical man, may some day assume unexpected importance.

Get at the Root of the Trouble

"THE Department of Labor deeply deplores the violence which has resulted in loss of life in the coal fields of Illinois. American workmen on both sides of the controversy over the relations between the mine workers and the mine operator have been killed and injured. Those who are guilty of this crime should be prosecuted to the fullest extent of the law. One of the unfortunate features of this deplorable occurrence is that the death of these men will accomplish nothing in the direction of a settlement of the dispute. Those responsible for the continuance of this strike, both among the workers and the employers, should seriously consider the fate of these workmen. No better argument can be advanced for the settlement of these disputes around the conference table than the dead bodies of a score or more of American workmen, who met a futile death in this outbreak. Surely in this civilized age, matters of dispute between men in industry can be adjusted without resort to bloodshed."

Such were the comments of Secretary of Labor Davis following the recent massacre in the Illinois coal fields. While none will disagree with the sentiments thus expressed, still they do not materially help the situation. The American people are becoming tired of recurrent disturbances in their fuel supply and want action.

It is reported that the subsequent conference between the President, the Secretary of Labor and John L. Lewis, representing the miners, was not productive of results owing to insistence of the miners upon a national rather than local wage agreements. The operators, for obvious reasons, desire the latter.

Justification, to a certain extent, probably exists for the stands taken by both the operators and the miners; but the outstanding fact, admitted by all, is that the coal industry operates under unsound economic conditions. These are responsible, more than any other factor, for the labor troubles, as well as periodic coal shortages with their accompanying profiteering.

Three years ago Secretary Hoover, while president of the American Institute of Mining and Metallurgical Engineers, made a careful analysis of the situation and pointed out certain remedies, but his recommendations met with opposition on the part of the operators and indifference on the part of the public. Since that time several bills have been prepared in Congress, some constructive, others destructive, but all have met the same fate at the hands of a powerful coal lobby.

It is time for the coal industry to clean house, but a house cleaning from within is better than one from without. The recent happenings in Illinois have aroused the indignation of the public, and as a reaction ill-advised legislation may be attempted. Obviously, the one way to avoid this is for the coal industry to place itself on a sound economic basis by taking losses where necessary, taking steps to procure a higher operating load factor and eliminating the speculative element.

Cheaper Fuel for the Oil Engine

IN A number of states the price of low-grade boiler oil is much less than that of refined fuel such as is customarily used in Diesel engines. The fuel advantage lies with the Diesel in the ratio of three or four to one, while the initial cost favors the steam plant at a two to one ratio, and it is evident that the hesitancy of many to replace steam by oil power has been justified while boiler oil sells for one-third that of refined oils.

On another page the subject of burning this cheap heavy oil in Diesel engines is dealt with. As the author points out, there is no structural reason why the Diesel engine should not take advantage of the low price of heavy boiler oil to reduce the fuel costs by fifty to seventy per cent. The problem is essentially one of flow through the fuel lines. With proper heating and filtering the handling of boiler oil from storage to the engine and its atomization are not even difficult. The minor engine adjustments and increased attention required are more than offset by the lowered production costs. That heavy oil may be used with success is attested by the experience of Diesels operating on the heaviest of Mexican fuels. One plant in particular is reported as using an oil which has a Baumé gravity of five, making the oil heavier than water. Oil-engine owners will do well to investigate the possibilities of boiler oil, of which a large stock is in storage at an extremely low price.

Secretary Hoover's understanding of the dangers of governmental intervention in business was well brought out by his remarks before the American Construction Council. Speaking of the problems before the industry, he said: "They cannot be solved unless there is co-operative action in industry. In these matters that are of vital public interest, there can be no successful issue unless they arise from the initiative of the industry itself. I do not believe these results can be accomplished by bureaucracy or government regulation."

PRACTICAL IDEAS from PRACTICAL MEN

Simple Method of Draining Steam Main

In plants where a number of boilers are connected to one header with a sectionalizing valve between each boiler connection, it is frequently necessary to isolate a section of the header to facilitate repairs to valves, etc. It is seldom that each section of header is fitted with a drain, and if this fills with condensation while shut off this water must be disposed of before steam can be turned on to the line.

A simple and effective means of draining the header, where it is located above the boiler and saturated steam is used, is to connect a small drain from the bottom of each tee at the boiler connection to the drum of the boiler at some convenient point above the water line.

There should be a valve installed in the drain, and it can be kept open while the boiler is in service and the condensation will be kept drained back to the boiler.

It should be noted, however, that in plants where the boilers are equipped with superheaters, this should not be done, as it would decrease the temperature due to the mixing with saturated steam. A. E. DURANT.

St. Paul, Minn.

Unsymmetrical Bolt Spacing

When the skilled mechanic has occasion to take down a machine, he will usually mark the parts with a center punch or chisel so that he will be able to replace them in their original positions. Sometimes another man is called upon to do the assembling, and he is likely to have difficulty in locating or interpreting the other man's marks and will make more or less serious errors in consequence. With a less careful mechanic the marking system is likely to be less complete, with a correspondingly increased liability of error. Some mechanics do not realize the importance of connecting the halves of a coupling together with the same bolt holes in line with each other as in the original installation, or the replacing of a valve bonnet or bearing cap without turning 180 deg. from its original position.

In the majority of cases these troubles could be eliminated and considerable time saved in taking down and assembling if the designer could overcome his natural tendency to produce a symmetrical layout of bolt holes. If he departs from the usual custom and places an occasional bolt a little off center, or nearer the edge than the corresponding bolt on the opposite end, there will be no perceptible increase in cost; but there will be only one way in which the piece can be assembled. The bearing cap, Fig. 1, is secured by two bolts symmetrically placed; the cap is quite likely to be reversed when replaced, and it may be puzzling to tell why the bearing runs hot. If the location of either bolt is moved $\frac{1}{8}$ in. in any direction, it will be hardly noticeable to the eye, but it will be impossible to reverse that cap in assembling.

The rectangular cover plate shown in Fig. 2 is secured by six studs laid out symmetrically. Unfortunately, perfect symmetry is rarely attainable; it will probably fit better in one position than in the reverse. In some cases it would be just as cheap and serviceable and

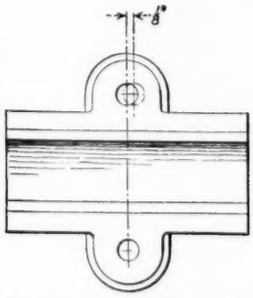


FIG. 1. BEARING CAP WITH ONE BOLT HOLE OFF CENTER

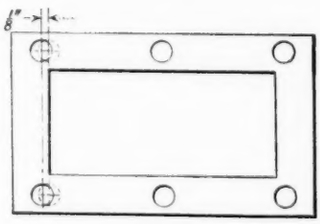


FIG. 2. COVER PLATE WITH HOLES UNEQUALLY SPACED

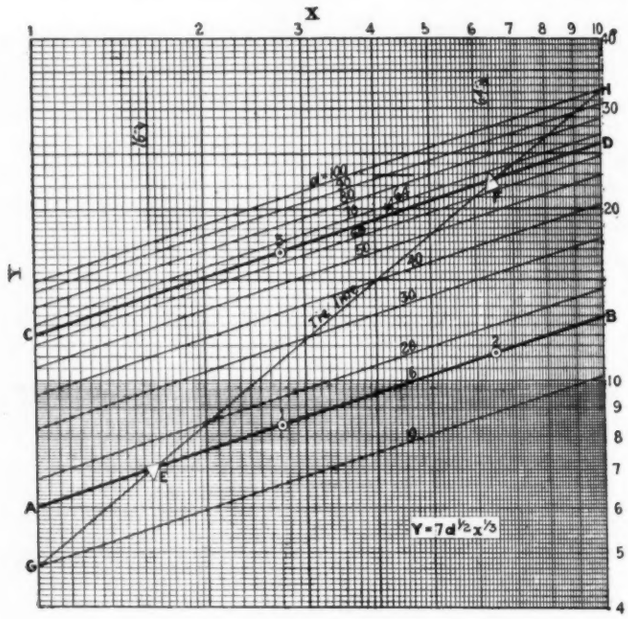
would present an even better appearance on the machine if it were slightly larger at one end than at the other. If this is too radical a departure from the accustomed practice, move the two studs at one end about $\frac{1}{8}$ in. farther from the end, as shown by dotted circles; it will take a keen observer to notice the change, but the plate will be replaced correctly.

The plant engineer will not have to look far to find cases similar to the foregoing. In some of them it is likely to be worth his while to provide a remedy by inserting an extra stud or dowel. It is not unlikely that he will find cases where two or more dowels are symmetrically spaced, or fitted bolts used in the same manner. In my opinion this is exceedingly poor practice as there is not much chance of their fitting perfectly if the piece is reversed, but they are likely to be sufficiently close to tempt the careless workman to use force to bring the parts together and cause more or less damage by the undue strain. H. M. PHILLIPS.

Washington, D. C.

Plotting Curves on Logarithmic Paper

Logarithmic ruled paper has come into general use in the plotting of certain forms of equation because the resultant curves are straight lines. In many cases these curves consist of a series of lines representing different values of a constant appearing in the equation, and this article explains a simplified method of plotting such



A SHORT-CUT METHOD FOR DRAWING A "FAMILY" OF CURVES ON LOGARITHMIC PAPER

First plot curves AB and CD for two values of d (16 and 64). Find the points E and F on these curves where X equals d (X equals 16 for AB and 64 for CD). An intersecting line through these points will cut each curve for d, to the point where X equals d for that curve. Hence the curve for $d = 40$, for example, will be parallel to AB and across GH where X equals 40.

a series which involves the actual calculation of only three values.

The general and most common equation used with log paper is in the form

$$y = bx^m$$

Suppose a series of curves are wanted for different values of b, and to make the example concrete we will assume one equation to be

$$y = 7d^{\frac{1}{2}}x^{\frac{1}{3}}$$

where b equals $7d^{\frac{1}{2}}$ and m equals $\frac{1}{3}$; d to be plotted for various values ranging from 10 to 100.

To plot this series of curves it is only necessary to calculate 3 points:

1. Assume $d = 16$, and $x = 27$; then $y = 84$.
2. Assume $d = 16$, and $x = 64$; then $y = 112$.
3. Assume $d = 64$, and $x = 27$; then $y = 168$.

Calculate 1 and 2, draw the line AB. Calculate 3; through this point draw the line CD parallel to AB. We now have two curves of our series for values of, $d = 16$ and $d = 64$. Select a point on the AB line ($d = 16$) at the intersection of this line and vertical (or horizontal) of equal numerical value (16) and connect this point with a point on the CD line ($d = 64$) which is the intersection of that line and a vertical (or horizontal, if previously used) of equal numerical value (64). This line we call a tie line, and through the intersection of this line with verticals (or horizontals if previously used) we can draw our series of curves parallel to the original line AB; that is, the intersection of the tie line and any vertical will be a point on a curve for a value of d corresponding to the numerical value of the vertical (or horizontal, if used).

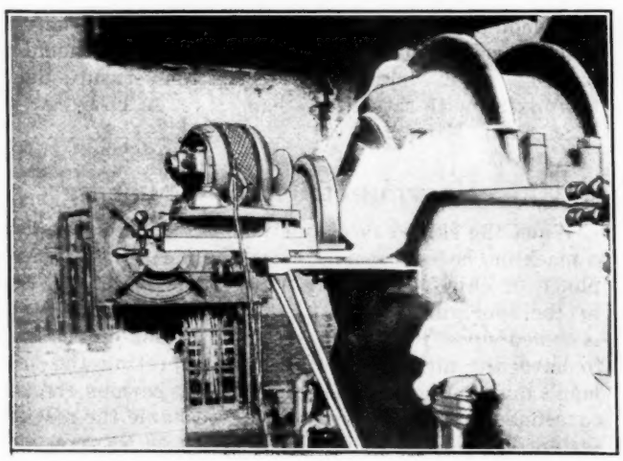
It will be noted that two tie lines can be drawn using either X or Y axis values. The result is the same in either case. This method is useful also in extending existing curves or data that are, or can be, plotted as straight lines on log paper. It should be noted that in reading the values of X at the top, and of Y at the right, a cipher should be added to the values shown.

Chicago, Ill. F. R. WHEELER.

Grinding Collector Rings on 20,000-Kva. Generator

It was recently found necessary to grind off the collector rings on a 20,000-kva. generator and to do this work in as short a time as possible. The rings were made of monel metal and were 16⅜ in. in diameter and 2½ in. wide. The surface of the rings was badly grooved. We first tried turning them down with a lathe tool, running the rings at 50 r.p.m., but the tools would not take a cut, so we made up the following grinding attachment and found it satisfactory.

The motive power for grinding these rings was supplied by a 1-hp. motor. The spindle of the motor had a lateral thrust of ¼ in., and we had to use a center in the opposite end to take up the thrust while grinding. The grinding was done with a 6-in. diameter carborundum wheel, ⅜ in. thick. The baseplate of the attachment was clamped to the bearing by the brush ring clamping bolts and was supported by two diagonal braces run from the bedplate of the turbine. The center of the grinding wheel was placed 5 in. above the ring center and at an

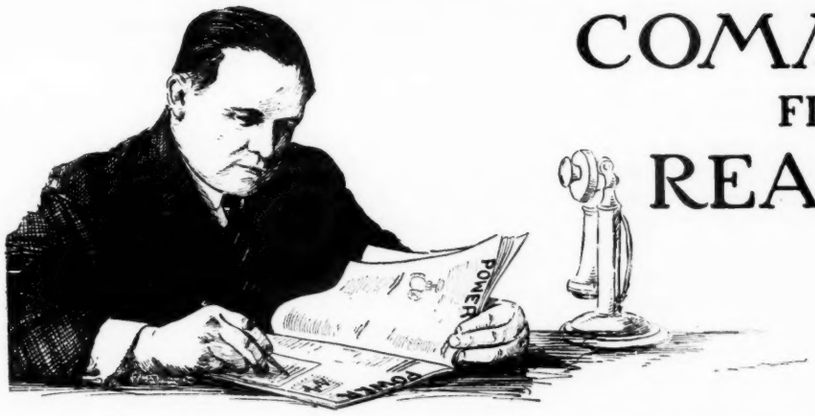


MOTOR GRINDER IN POSITION FOR TRUING UP RINGS

angle of 20 deg. with the face of the ring to prevent chattering while grinding.

The first ring was ground off in 2 hours, 50 min., ⅞ in. of metal being removed. The second ring was finished in 2 hours, 20 min., ⅝ in. of metal being taken off. The turbine was running at a speed of 100 r.p.m. and the grinding wheel at 1,720 r.p.m. The job of rigging up the grinding attachment and grinding the rings was completed in 11 hours and a first-class job was done.

Cabin Creek, W. Va. J. M. JONES.



COMMENTS FROM READERS

Comparative Tests on Coal and Oil Burning Boilers

On page 934 of the June 13 issue data are given on comparative tests of oil and coal under similar boilers in the same plant. The free oxygen in the flue gas is substantially the same in both cases. The CO in the coal-burning test accounts for $\frac{0.44}{11.4 + 0.44} \times 10{,}000$ B.t.u. = 370 B.t.u.

The 32-degree-higher flue-gas temperature with coal accounts for 128 B.t.u. more as follows: 16.8 lb. gas per lb. coal × 0.238 specific heat × 32 deg. temperature difference = 128 B.t.u.

The total per cent difference = $\frac{370 + 128}{14{,}700} \times 100$ = 3.4 per cent, yet the efficiencies given were 71.5 per cent for oil and 52.6 per cent for coal.

Lawrence, Mass. THOMAS F. WALSH.

Improved Method of Cylinder Lubrication

With reference to the article on "Improved Method of Cylinder Lubrication," by O. Janzen, in the May 16 issue, many engineers today put into effect suggestions that point to a saving in power-plant operation at one point and at the same time cause a big expense at another point.

I advise those who may consider the use of one large lubricator in place of a small one on each unit, to consider first their local conditions, as in the majority of plants today each engine is equipped with a water separator and drained by a trap. Risers and low points in steam lines also have traps, and the returns of all these traps as a rule go to a heater from which the water is pumped into the boilers. In some cases the returns are pumped directly to the boilers. If one large lubricator is used in a plant of this kind, a few cents saving in oil will cost dollars somewhere else, as a part of the cylinder oil will collect in separators and traps and will eventually reach the boilers.

Some years ago I was called into a plant where live steam was used directly to heat pickling vats. The product leaving the vats was spotted, and much time was lost in removing these spots. At first a boiler compound was believed to be the cause, but a test showed that it was oil.

In the boiler room on the main steam line leading to the feed pumps an old steam-gage connection was converted into a lubricator connection for oiling the pumps. From the same end of the steam main a branch line supplied the pickling vats, and the oil was distributed to them as well as the pumps. The lubricator was disconnected, and for several months traces of oil were still found in the system.

Mr. Janzen's suggestion, however, has its good points, and it gives the cylinder oil a better chance to mix with the steam. Nevertheless it should not be used where clean steam required for commercial purposes is taken from the same main as the other units. R. MILLER.

Canandaigua, N. Y.

Evaporation of Lubricating Oils

In the May 16 issue, Mr. Osborne gives a very thorough discussion of the effect of evaporation of lubricating oils on the general efficiency of lubricating systems where constant circulation of oil is necessary. In connection with this topic, however, there is another factor that occurs and that may be used to determine in advance the relative evaporation of various oils under consideration.

It is clearly understood that when two or more oils of different viscosities are mixed together, the resultant oil will have a viscosity in proportion to the percentage and viscosity of the oils mixed. The physical qualities of the components are not perceptible upon visual examination, and to all appearances the oil is entirely satisfactory. This may or may not be the case.

The change in viscosity through evaporation is not uniform for all oils under the same conditions, as may be quickly demonstrated by simple tests. This may also mean that the rate of evaporation in all cases is not the same. It is found that with straight-run oils of the same crude and of the same initial viscosity, the increase in viscosity is, roughly, directly proportional to the loss by evaporation.

The main point desired to be brought out, however, is that there is a means of checking the mixing of the oil. This is done by the fractional-distillation process. Oils of a mixed or blended nature usually show a sharp slope to the curve after the second fraction, while the straight-run oils have much less variation between the first and last fractional viscosities. The curve referred to is obtained by plotting the viscosity of the approximately equal fractions as ordinates against the percentage of the total sample which the fractions represent, as abcissas, the latter being plotted cumulatively. The more nearly horizontal the curve the more uniform the oil and the less change in viscosity with evaporation. Of course a perfectly horizontal curve cannot be obtained; that only represents the ideal.

When an oil is found to be composed of very light

and very heavy fractions with practically no intermediate-bodied oil, it is to be expected that the lighter-bodied oil will be the first to pass off as vapor, leaving the heavier-bodied oil. The rapidity of this evaporation, therefore, depends on the viscosity and flash point of the lighter fractions. It must be kept in mind, however, in comparing oils in this manner, that the comparison be made between oils of the same base or crude, as the characteristics of the crudes are fundamentally different. The fractional method in comparing oils of different crudes may be considered useful by some engineers, but a discussion of that phase of the subject is not being considered in these remarks. A comparison of oils of the same base only is considered.

In a circulating oil system the evaporation of oil is important because of the material loss, the change in viscosity which directly affects the bearing friction, and the difficulty of separation of emulsion and sediment. The fractional method, with curve plotted as herein discussed, will give a good check on quality, with a close approach to the horizontal as the ideal.

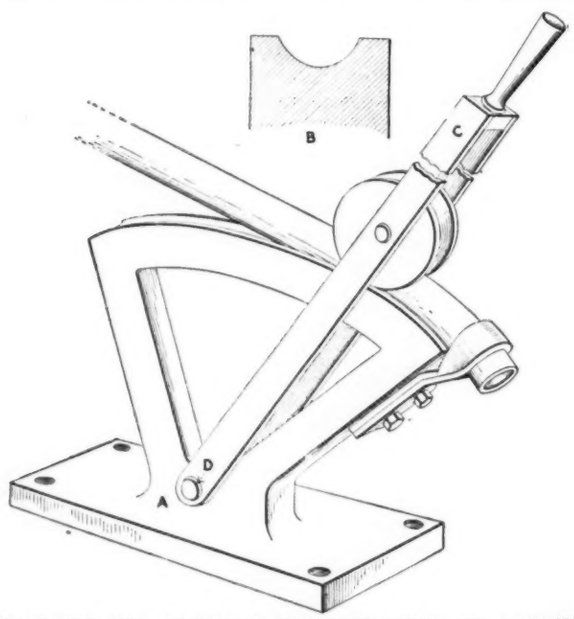
Bound Brook, N. J. H. R. SMITH.

Bending Large Conduit

Referring to the article by H. A. Geis on his method of bending conduit, in the April 11 issue, I consider that I have a more practical method of doing this work, by using the machine shown in the illustration.

The frame *A* is a cast-iron stand with the top face shaped as at *B*. Several liners are made up of sheet plate for placing in the groove when bending conduit of different sizes.

The steel arm *C* is pivoted at the point *D* and fitted with a roll having a grooved face of the same curvature and diameter as the tube to be rolled. By using different-sized rolls on the lever and different liners on the arm, several sizes of conduit and tubes can be bent in workmanlike manner.



MACHINE FOR BENDING VARIOUS SIZES OF CONDUIT

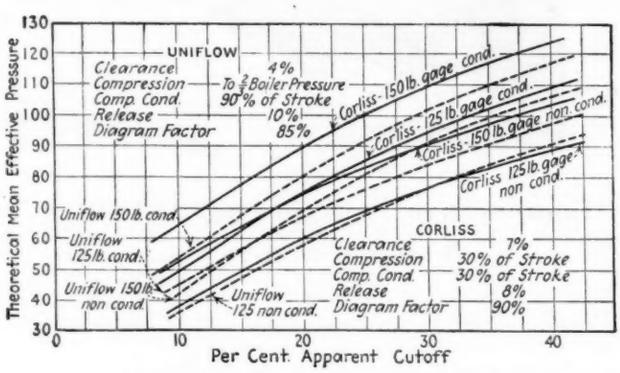
The method of using the machine is to clamp the tube end with the tube resting in the groove of the stand, then move the lever with its roll over the tube.

Fall River, Mass. ARTHUR D. PALMER.

Mean Effective Pressures

In the June 6 issue of *Power* was shown a table of mean pressures per pound of absolute pressure. The values there given, when corrected for the mean back pressure, will give the theoretical mean effective pressures.

Engineers as a rule fail to realize that the type of engine has a decided influence upon the value of the average back pressure. The unaflow engine begins the compression very early in the stroke, 0.9 for condensing operation and in non-condensing work somewhat later, the compression running up to two-thirds of the boiler pressure. On the other hand, the Corliss does not close the exhaust valve until the piston has reached to within 0.3 to 0.25 of the end of the stroke. These variations in the compression affect the average back pressure.



MEAN EFFECTIVE PRESSURES OF CORLISS AND UNAFLOW ENGINES

In the chart are shown curves for unaflow and Corliss engines, operating condensing and non-condensing. A study of these curves will show why a unaflow steam engine must have a larger stroke volume for the same horsepower with the same apparent cutoffs. In making this chart, the various values of clearance, vacuum, release, etc., as shown on the chart, have been used.

Hamilton, Ohio. MARSHALL BARKER.

Heat Transfer in Double-Pipe Ammonia Condenser

In the March 28 issue of *Power*, page 514, Roscoe H. Hysom gives the heat transfer in double-pipe ammonia condensers. He seems to have neglected the aftercooling of the ammonia, and while in the example given it does not seriously change the total number of B.t.u. transferred, it should be included so as to make the computed result as nearly accurate as possible. Usually, there are so many unaccountable errors to contend with that all known factors should be given consideration at least.

There are three distinct heat-transfer actions carried on in the condenser: (1) Cooling the superheated gas to saturation temperature; (2) condensing the gas; (3) cooling the liquid ammonia from saturation temperature to as near the temperature of the ingoing water as possible.

In the problem covered by Mr. Hysom the ammonia vapor is at a temperature of 280 deg. and the cooling water enters at 60 deg. F., while the ammonia leaves the condenser at 70 deg.

NH_3 liquid at 70 deg. F. has a heat content of 42.1 B.t.u.

Total heat of superheated NH_3 at 280 deg. F. = 676 B.t.u.

Hence, total heat removed 676 — 42.1 = 633.9 B.t.u.

Of this the aftercooling section removes, 72.5 — 42.1 = 30.4 B.t.u.

The aftercooling section removes $\frac{30.4}{633.9} = 5$ per cent.

The condensing section removes $\frac{488}{633.9} = 0.5$ per cent.

The superheated section removes $\frac{115.6}{633.9} = 18$ per cent.

Temperature rise will be as follows:

Aftercooling section = 5 per cent of 10 deg. = 0.5 deg.

Condensing section = 77 per cent of 10 deg. = 7.70 deg.

Superheat removing section = 18 per cent of 10 deg. = 1.8 deg.

The mean temperature difference is

$$Tm_a \text{ (aftercooling)} = \frac{(96 - 60.5) - (70 - 60)}{\text{Log}_e \frac{(96 - 60.5)}{(70 - 60)}}$$

= 20.1 deg.

$$Tm_c \text{ (condensing)} = \frac{(96 - 60.5) - (96 - 68.2)}{\text{Log}_e \frac{(96 - 60.5)}{(96 - 68.2)}}$$

= 32.2 deg.

$$Tm_s \text{ (superheat)} = \frac{(280 - 70) - (96 - 68.2)}{\text{Log}_e \frac{(280 - 70)}{(96 - 68.2)}}$$

= 90.1 deg.

The mean value of heat transfer for the whole condenser, using a heat transfer of 150 B.t.u. per sq.ft. per hour per degree difference, is computed by the formula,

$$Km = \frac{\frac{H_a}{Tm_a} + \frac{H_c}{Tm_c} + \frac{H_s}{Tm_s}}{Sm}$$

where H_a, H_c and H_s represent the heat carried away by the aftercooling, condensing and superheat-removing surfaces respective, and Tm_a, Tm_c, and Tm_s are the mean temperature differences respectively.

Sm is the total effective surface in the three sections of the condenser. Therefore

$$Km = \frac{\frac{H(total)\ (0.05)}{20.1} + \frac{H(total)\ (.77)}{32.2} + \frac{H\ (total)\ (.18)}{90.1}}{Sm}$$

$$Km = \frac{H(total)\ \frac{0.05}{20.1} + \frac{0.77}{32.2} + \frac{0.18}{90.1}}{Sm}$$

Tm for whole condenser is equal to

$$\frac{1}{\frac{0.05}{20.1} + \frac{0.77}{32.2} + \frac{0.18}{90.1}} = 35.2 \text{ deg.}$$

The amount of heat transferred per square foot may be found, since $\frac{H}{S} = Km \times Tm = 150 \times 35.2 = 5{,}280$ B.t.u. per sq.ft.

H. A. LEEUW.

New York City.

[In Mr. Hysom's discussion the aftercooling effect was ignored in order to simplify the computations as here shown, the difference is about 2½ per cent.—Editor.]

Weak Points in Comparison of Coal and Oil

There was an article in the June 13 number of *Power* entitled "Comparative Tests on Coal- and Oil-Burning Boilers." This described two tests that were made on return-tubular boilers using oil and coal respectively, the efficiencies obtained being 71.5 per cent for oil and 52.6 per cent for coal, and the cost per 1,000 lb. of steam working out at 52.1c. and 55.7c. The figures given can hardly be taken as typical, and place the coal-burning boiler in rather an unfavorable light.

In the first place, even with a varying load, an efficiency of only 52.6 per cent for coal with a heating value of 14,722 B.t.u. would appear to be rather below what might be expected, as at least 60 per cent should be obtained under such conditions. Again, on figuring out the cost of the coal, which, incidentally, is not stated in the article, this is found to be $8.25 a ton. This is rather surprising, when it is considered that a good grade of steam coal can, under normal conditions, be obtained at a price around $5 a ton.

Assuming that an over-all efficiency of 60 per cent can be obtained and that 13,000-B.t.u. coal is used, costing $5 per ton, the matter is presented in a somewhat different light, as the cost per 1,000 lb. of steam would then be about 32c., showing a saving over oil firing of approximately 40 per cent. In a plant fitted with stokers, where an efficiency of 70 per cent should be obtainable, the saving over oil fuel would then be about 50 per cent.

When it is considered that one cent will purchase 52,000 B.t.u. in the shape of coal and only 29,000 B.t.u. in fuel oil, assuming prices of $5 a ton and 4.7c. a gallon, it is evident that the oil-fired plant is under a heavy handicap and cannot compete with coal upon an economic basis unless unusual conditions exist, in spite of the admitted increased convenience and cleanliness when oil is used.

D. F. GRAHAME.

Toronto, Canada.

Connecting Alternators in Parallel

Referring to the inquiry from Albert Bankes in the issue of May 16, page 789, as to why the generators cannot be connected in parallel, the difficulty in operating the generators in parallel on the 5,000-volt bus is apparently due to the triple-frequency current flowing through the star connection to the ground and back through the generator windings. This triple-frequency current is due to the generator wave shape. Since this triple-frequency current operates at three times the fundamental frequency, the current in the ground connection will be three times the amount of the triple-frequency current in each phase of the generator winding, hence may reach a considerable value.

In order that this current may circulate, it is necessary that a complete electrical connection be established between star points of the generator windings and also complete through the line wires. This difficulty is not experienced when paralleling on the 525-volt bus, because the two transformer banks which are connected star to star serve to interrupt the complete electrical circuit mentioned. The difficulty can be partly overcome by increasing the resistance in the ground connection.

R. R. COWLES, Assistant Engineer,

San Francisco, Cal. Pacific Gas & Electric Co.

QUESTIONS AND ANSWERS

Oil in Boilers

Is a boiler as likely to become burned from injection of kerosene as from heavy oils; and will not kerosene protect the boiler from rusting? T. W.

Heavy oils, like engine cylinder oil derived from engine exhaust or otherwise finding its way into a boiler, are more likely to cause burning and bagging than light oils like kerosene. Kerosene acts as a preservative against rust, but is likely to cause leakage at joints, and when carried over with the steam into the piping system, causes leakage of rubber gaskets and most kinds of soft packings.

Metering Water by Valve Opening

How can the rate of flow of water through a globe or gate valve be estimated for the purpose of metering or measuring the rate of flow through the valve? W. R. B.

The passages in a valve give rise to an irregular churning of water passed through the valve, so that the percentage of theoretical discharge varies considerably for different valve openings and velocities. Hence metering could not be depended upon even for approximate estimates of discharge, unless based upon calibrations of the flow made under identical conditions of valve opening and the same difference of pressure on opposite sides of the valve.

Cleaning Up An Engine

What is a good method of cleaning up an engine that has stood idle for some time? H. L. J.

Gummy deposits of oil should be softened with a paste of potash and removed by scraping with a putty knife or other flexible scraper. In places where the gum seems to be burnt into the metal, the finished surfaces can be brightened by sandpapering, being careful to do the rubbing so the marks will be in the same direction as those of the original finish. After cleaning, the parts should be flushed clean with water, dried and oiled. The use of loose emery or of emery cloth or emery paper is objectionable as particles of the emery that may get between rubbing surfaces are likely to cause cutting that is difficult to stop.

Reseating Small Slide Valve

We have a small slide-valve engine which is occasionally used, but the valve leaks badly. How can it be improved without sending the engine to a repair shop? J. E. H.

The high spots in the valve and seat can be roughly determined with a straight-edge, and for determining them more accurately, spread a very light film of red lead over the valve seat and face with the fleshy part of the hand, and rub the valve over the seat in all directions. The lumps then can be reduced with a flat file with the tang offset enough to clear a thin handle. Try the surfaces together from time to time in regular position and with the valve reversed. When the surfaces have apparently been made true, they should be scraped and retested. Scraping can be performed with the end of a tool like a flat file ground to a nearly square edge, holding the edge firmly to the work and giving a side swinging movement to the free end of the scraper, imparting fan-shaped marks with an even frosted appearance.

Taking Leads of Bearings

How are leads taken of a bearing and how is the information of value for making adjustments? R. N. C.

The purpose of taking leads is to determine the amount of clearance and to obtain information of whether the bearing requires refitting. The method of taking a lead is to remove the cap and lay a piece of soft lead wire, No. 16 or 18 B. W. G., inside of the cap or along the journal parallel to the axis of the bearing; or lay one piece of the lead wire across the axis at the middle of the bearing and one at either end. The cap is then set down hard on the liners and the lead wire becomes compressed to a thickness that is equal to the clearance. The leads thus afford means of gaging the clearance that is obtained when the bearing is set with the same liners or, by comparison with the thickness of a lead previously taken at the same part of the bearing, the difference of thickness of the leads measured with a micrometer, gives the amount of wear that has taken place in the interval and shows what changes are necessary for refitting the bearing with the desired amount of clearance.

Combining Detached Stacks for One Boiler

We have two water-tube boilers, one of which is directly connected with a 42-in. diameter round steel stack 60 ft. high, and the other is connected to a 36-in. x 36-in. brick stack, 65 ft. high. It is intended to use but one boiler at a time. Is it possible to connect each boiler with both stacks and by so doing obtain more draft for the boiler that may be in use? L. S.

There would be a gain of draft when using but one of the boilers by having the stacks and boilers connected to a common flue at any time when one boiler is out of use, and all air leaks are sealed off from the common flue, and when the gas pressure in the flue is greater than the gas pressure in both of the stacks.

That is to say, draft gages connected with each chimney must show more draft than a draft gage connected with the common smoke flue. The stacks are nearly the same in draft capacity, but upon starting a fire in the furnace of one of the boilers, other things being equal, the draft would become established in one stack before the other, and a back draft is likely to occur into the common smoke flue from the other stack. During the time such a condition existed there would be less furnace draft than if the boiler were connected with one stack, because the stack in which draft was established would be burdened by air received from the other chimney, in the same way that the draft of heating apparatus is commonly checked by admitting air to the stack connection. To establish draft in the less active chimney when starting up, the more active stack draft should be throttled by a stack damper. The equality could be regulated from observation of draft gages in the stack connections, and when the more sluggish chimney has thus been put in operation the damper of the other may be opened a little at a time until full wide open and the fire can be regulated with the boiler uptake damper.

Lap Joints Unsuitable for Longitudinal Seams of Return-Tubular Boilers

Why are lap joints prohibited and butt and double-strap joints required for the longitudinal seams of horizontal return-tubular boilers? A. L. M.

Pressure in a boiler exerts a pull or tension in the metal of the shell. In a lap joint, such as illustrated at *a* and *c*, Fig. 1, the plates are eccentric and the stress pulling across the joint has a tendency to draw the plates into line and for the joints to assume the distorted forms shown at *b* and *d*. This bending action is less when the plates are joined with a broader lap, double-riveted, as shown at *c*, and the bending action may be reduced by bending the plates before they are riveted, but the rivets then are exposed to considerable tension as well as shearing stress. In either case the bending action is likely to open the laps and leakage

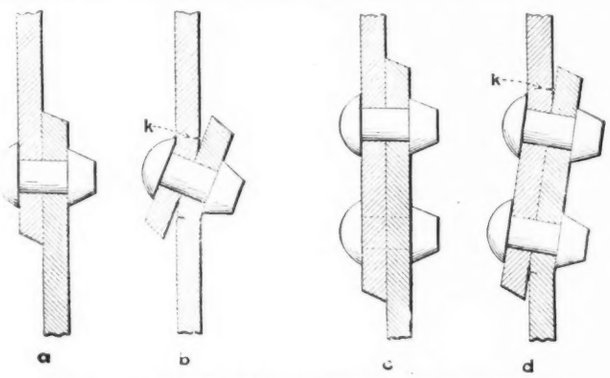


FIG. 1. ILLUSTRATING METHOD OF FAILURE OF LAP JOINTS

and cracks are likely to occur where the distortion is most severe. The bending action comes into play every time a boiler is fired up, or with a rise of pressure, and the plates are again straightened out when the boiler cools.

With a single-strapped butt joint, such as shown at *e*, Fig. 2, all the rivets are in single shear and there also is a tendency to bend the plates and the strap to the form illustrated at *f*.

This continual bending in lap joints and in single-strapped butt joints often causes cracks *k* to be formed in the plates beneath the laps, and as these cracks are widened by corrosion and are hidden, they are dangerous. So many boiler failures have been traced to cracks formed in this manner, particularly with lap

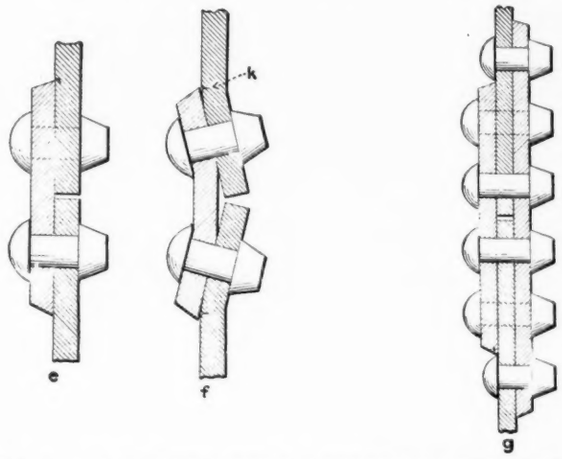


FIG. 2. SINGLE AND DOUBLE STRAPPED BUTT JOINTS

joints, that these joints have come to be regarded as unfit for longitudinal seams of power boilers or drums that are greater than 36 in. in diameter and then only if the working pressure is not in excess of 100 lb. per sq.in., unless staybolted.

In a butt and double-strap joint, such as shown at *g*, Fig. 2, the plates to be joined lie in line with each other, the joint is built up nearly symmetrical by inside and outside cover plates, and if the main plates and cover plates are curved to true circular form before the joint is riveted, there will be little or no tendency to bending and cracking.

Direction of Running Motor-Driven Compressor

We have in our plant a two-stage air compressor 21 in. x 23 in. x 16 in., driven 214 r.p.m. by a synchronous motor. Will this machine run as quietly "running over" as "running under?" Why are motor-driven air compressors generally run under instead of over?

H. S. B.

Quieter running of a motor-driven compressor is obtained by "running under"—that is, when the crank falls in the beginning of a stroke from the cylinder toward the crankshaft—for then the alternate thrust and pull of the connecting rod, as well as the weight of the crosshead, bring the pressure of the crosshead on the lower guide. In a steam engine, where the power is transmitted from the crosshead to the crank, pressure is brought on the lower guide and quieter operation is obtained by "running over." By "running under" in case of a motor-driven compressor, or "running over" in case of a steam engine, there is better opportunity for lubrication of the guide that receives the principal wear, better opportunity of adjusting and maintaining alignment of the crosshead and less tendency of the crosshead to pound on the guides.

Motor-driven compressors are run under more generally than over, so the pull of the driving belt will come on the under side of the belt and thereby better provide against slippage of the belt on the motor driving pulley.

National District Heating Association Holds Record Convention

FROM June 20 to 23 inclusive the National District Heating Association held its thirteenth annual convention at the Breakers Hotel, Cedar Point, Ohio. Under the leadership of President Walker much valuable work was done during the year and the results were apparent during the four-day session of the convention. The committee reports and papers were exceptional and well received. Registration showed an attendance of 130.

Tuesday morning was devoted largely to routine business. In his address President Walker referred to the present improved conditions for central heating and the need of still greater efforts on the part of the association to keep pace with the industry. While the committee reports were extremely valuable, it was his belief that they could be supplemented to advantage by more papers by individuals, and owing to the wealth of material now available, a fall convention might well be considered. There was need for more reliable statistics regarding the industry, and when funds were available it would be highly desirable to conduct a campaign of education of the public as to the true nature of central heating service. Finally, the vast number of technical problems in the industry on which there was little accurate information, called for a great deal of research. It was the duty of the Association to support some research work either by the Research Bureau of the American Society of Heating and Ventilating Engineers or through fellowships established in the technical schools.

H. T. Luscomb presented the report of the Heating Research Committee which contained the results of a study of the utilization of exhaust steam for heating in electric generating plants in six buildings in New York City and a number of curves based upon the building heating data prepared for publication in the Handbook.

Combination System Proves Successful

In a paper on the "Value and Method of Steam Generating Plant Interconnection," J. C. Butler described the system adopted by the Illinois Maintenance Company of Chicago, which is a compromise between the block and central station plans. High pressure tie lines are run between plants already operating on the block plan. One of the plants is made the nucleus of the system and being operated near capacity throughout the entire year is provided with coal and ash-handling equipment and other apparatus leading to a low production cost. The investment charge is slightly greater than that of the block plant but much less than in the case of the central station. By operating the less efficient plants only in the coldest weather and supplying the entire service from one station during the summer, the labor is reduced to a minimum and the efficiency of the system is at its best.

For the conditions existing in Chicago this plan of interconnection was endorsed in the discussion of the paper. The same procedure is to be adopted in Boston and already interconnection has been put in effect in St. Louis with large reductions in maintenance and labor. One great advantage was the flexibility secured. In addition the surplus capacity was available to take care of potential business, giving a distribution system practically free of cost. Advantage could be taken of the coal storage in the various plants and something might be done in taking on steam service for the four or five warmer months to improve the annual load factor. With a number of isolated plants that could be heated nicely from one plant, it was suggested that the electric loads of these plants be grouped and the advantage of a bulk rate given rather than treating each electric customer individually. This would reduce the gain from central heating but would tend to eliminate competition from private plants.

C. H. Day, chairman of the Heat Utilization Committee, presented an interesting report in which he suggested the use of temperature-consumption charts, as they offer opportunity for comparison from year to year and stimulate interest in ways and means of eliminating waste. Keeping valves, radiator traps and vacuum pumps in good condition, the elimination of cold water jets at the pump and tight windows offered innumerable opportunities for saving. Overheating of buildings was another factor to be watched. Shutting off the steam at night had an important bearing. In certain buildings cited the saving in steam consumption amounted to 47 and 48 per cent, respectively. These savings were larger than the average, but savings of 20 to 30 per cent could be found easily in the records of member companies. It was suggested that the temperature inside the building never be allowed to get below 50 to 55 deg. F. The steam might be turned off manually by the watchman but two tests were cited in which thermostatic control on the house valve showed savings of 11.5 and 24 per cent. Another method of saving steam was by using the heat in the condensate to preheat water entering the domestic heater. Economizers of this character installed in two buildings at costs of $1,000 and $1,200, had saved steam at 70c. per 1,000 lb. to the values of $495.95 and $417.20 over periods of 140 days in the first case and 153 days in the second. The economizer also gave additional heater capacity.

Condensers Discussed

The use of jet water condenser in the vacuum line was to be prohibited. Surface or closed-type coolers used to heat the domestic hot water showed savings up to 20 per cent. The double-pipe counterflow condenser had been very effective. In certain cases the condensate, or the water itself, had been conserved, as well as the heat, by discharging it directly into a swimming pool instead of to the sewer. The use of vacuum generally was discouraged, the consensus of opinion being that even when vacuum pumps were installed, their use should be limited to speeding up circulation when getting steam on the building and even then the vacuum should be as low as possible. Properly laid out gravity systems without vacuum pumps showed better results and reduced greatly the maintenance difficulties imposed by a large number of vacuum valves.

The comprehensive report of the Station Operating Committee was presented in abstract by H. A. Woodworth and R. G. Felger. It dealt with the central steam heating system that had been built up in St. Louis and the linking together of some twenty-four small plants, giving the equipment of each, operating methods, costs of handling coal and ash, recovery of unburned fuel, refuse and other data. In this section of the report were included comments on the operation and economy of the Lakeside powdered coal plant at Milwaukee.

Following was a section dealing with the power plant reports and the permanent pyrometer systems of the Detroit Edison Co. At present two pyrometer systems were in use; one the nitrogen gas-filled tube and the other the iron-constantan thermocouple using the potentiometer for the indicating instrument. The latter had given the best satisfaction and had been adopted in most of the plants. Cinder eliminating fans were given some space in the report. Another section dealt with Coxe stoker performance in the Edison Building, Chicago.

The installation tested consisted of a three-pass cross flow watertube boiler with 6,280 sq.ft. of surface and fired with a Coxe stoker 10 ft. 4 in. wide and 15 ft. 2 in. long. The fuel was about equal parts of anthracite dust and bituminous coal screenings. It had been reported that the installation made smoke and gave high flue gas temperatures. The investigation was undertaken to find the causes and the remedies for these troubles. The worst trouble encountered was the formation of clinkers on the side walls.

this being eliminated by ventilation. The concluding portion of the report discussed the feed-water system and the troubles encountered, making special mention of the elimination of moisture in the steam before leaving the boiler.

The discussion turned chiefly to side wall clinker and its elimination by the use of carborundum brick, side wall tuyeres or air ducts on both underfeed stokers and chain grates. Side wall drip ledges extending 2 in. out from the wall had been used to advantage as they allowed the slag to hang free so that it was easy to break it off with slice bars. Secondary combustion due to high gas velocity had been eliminated in one case by drilling several holes in the top of the wind box of a forced-draft chain grate. Reducing the differential in pressure between the wind box and furnace gave better distribution of air and eliminated the difficulty.

Records Provide Incentive for Operators

Posting of records to stimulate interest as in the Detroit plants had worked out better than a bonus system. In Pittsburgh the percentages for each plant and the man-hours arranged like a baseball record, appealed to the sporting instincts of the men. Although until recently the potentiometer had been considered a laboratory instrument, it had given good satisfaction and was considered very accurate as the circuits were balanced and the resistence of the leads did not enter into the results.

A valuable paper on "The Fusibility of Coal Ash," by A. C. Fieldner and W. A. Selvig, was presented in abstract. It gave the results of work inaugurated by the Bureau of Mines to define fusibility and to develop a tentative standard method for its determination. The equipment was described, also the preparation of the ash and indication given of the composition of ash and the distribution of ash-forming constituents in coal. The relations of composition to fusibility and of fusion temperatures to clinker formation were considered and a summary was included in the paper on the fusibility of the ash of American coals.

In the discussion of the paper it was stated that clinker formation in the furnace depended largely on furnace pressure and the relative proportions of heating surface exposed to the radiant heat of the fire and the area of refractory surface lining the furnace, all of which had a direct bearing on furnace temperature. There was call for data relating to powdered coal and commercial screenings.

The "Operating Statistics Committee" made a report of progress.

During the past year the Committee on Rates, L. E. Young, chairman, had examined the rate forms of 191 heating companies and in its report at the convention gave a summary of what had been found. Recommendations were made for metered service with an annual demand charge based upon required radiation, a condensation charge with steps based upon the number of thousand pounds of steam used per month, a net minimum monthly charge for each month of the year in which service is supplied and the insertion of coal and labor clauses as a part of the rate schedule to provide for the automatic adjustment of rates.

J. C. Butler, chairman of the Committee on Meters and Accessories, abstracted the report, the greater part of which was devoted to the installation and maintenance of the various types of steam flow and condensation meters, together with the factor calculations of these meters and descriptions of new meters. Comments were made in the discussion to the effect that flow meters would measure with accuracy low-pressure steam under variable pressure. Different types of meters had checked and the readings from either corresponded closely with the records of the high-pressure meters on boiler steam. In certain test work progress was being made in introducing satisfactory lubrication for condensation meters.

An innovation at this convention was a provision in the program for a "round table" on new appliances and new methods, each manufacturer being allotted 10 minutes to give the details of his device without reference to other makes of equipment. The presentations on meters followed the committee report. In behalf of the General Electric Co., R. E. Woolley made mention of two new meters; one a mechanical meter, a modification of the present type F instrument, which gave combination records of flow and temperature on flow, pressure and temperature, and a new electrically operated meter. Essentially this meter was a transformer of which the primary coil was placed in a chamber so arranged that mercury formed a short-circuited turn around it. As the height of the mercury in the chamber varied in accordance with changes in the differential pressure through an orifice in the steam line, the resistence of the mercury coil changed and varied the current values in the primary and therefore the reading of the instrument. With the rise and fall of the mercury the records were continuous.

For the Bailey Meter Co., Mr. Condee reported a low-pressure steam meter through which the drop had been reduced to 4 in. of water and also the development of a new pressure compensating device, while Mr. McGregor announced the two new Republic boiler meters; one combining steam flow and CO_2 and the other the zero relation meter giving steam and air flow. Among condensation meters the new Cadillac meter of the Central Station Steam Co. and the Adsco rotometer of the American District Steam Co. were featured.

F. Paul Anderson, director of research, American Society of Heating and Ventilating Engineers, spoke incidentally on altruistic things pertaining to the engineer, the necessity of confining college work to fundamentals, and specifically of the work the laboratory was doing. Its equipment and trained corp of workers were at the service of the Association.

Performance in Federal Buildings

Other papers presented at the convention were one by James A. Donnelly, on "Temperature Control by Fractional Distribution of Steam in Large One- and Two-Pipe Systems," and a contribution by Nelson S. Thompson on "Central Station Service in Federal Buildings under Control of the Treasury Department." This paper contained a wealth of information on initial and operating costs and on Government practices determining whether steam and electric services are to be purchased or generated. An abstract of this paper will appear in an early issue.

N. W. Calvert presented the report of the Underground Construction Committee. It was devoted to the technique of welding pipe for underground steam mains, the advantages gained and the method of testing welded pipe.

D. S. Boyden read the report of the Public Policy Committee. A suggestion offered and favorably acted upon by the convention was a compilation citing the references of court rulings on public utilities, which were to be referred to the Educational Committee for publication.

A compilation of 585 up-to-date forms from 45 heating companies, arranged in company groups was presented by E. L. Wilder as the report of the Rules and Regulations Committee.

Continuation of the "round table" brought out a variety of information on Ric-Wil sectional conduit, the Huber hand stoker, Horning pressure and temperature control, a device designed by D. S. Boyden to give indication of excessively hot condensate from heating services, Archnu high temperature cement and key hot joint paste furnished by L. S. Shaw & Co.

A closing event of the convention was the award of a $50 prize donated by the American District Steam Co. for the best system of records for a heating plant. From five entries the records presented by O. W. Kastens, superintendent of heating for the Central Illinois Light Co., were considered best.

The following officers were elected unanimously: President, E. L. Wilder, of Rochester; first vice-president, F. B. Orr, of Chicago; second vice-president, L. E. Young, of St. Louis; third vice-president, J. C. Hobbs, of Pittsburgh; scretary-treasurer, D. L. Gaskill, of Greenville, Ohio; executive committee, J. H. Walker, of Detroit, C. H. Day, of Cleveland, and R. A. Heitbrink, of Muncie, Ind.

Stoker Manufacturers' Association Meets

The fifth annual meeting of the Stoker Manufacturers' Association was held at Griswold Hotel, Eastern Point, New London, Conn., June 20-22.

The first session was called to order on Tuesday forenoon by President Maxwell Alpern. After the reports of the Executive Committee, treasurer and secretary had been disposed of, C. E. Harrison, of the American Engineering Co., presented a paper on "Stoker Repairs and Replacements," which was discussed by Edwin Fitts, of the Detroit Stoker Co. and others. Much of the discussion dealt with the details of handling orders for repairs and replacements so as to insure quick service and accurate identification of the desired parts. Stress was also put upon the desirability of inducing the customer to order parts from the original manufacturer, from the point of view of maintaining the integrity of the stoker and avoiding a division of responsibility.

In the afternoon a kicker's handicap golf tournament was played, and in the evening the annual dinner was held, at which Frederick P. Fish, chairman of the National Industrial Conference Board, spoke on the "Control of Business by Government Boards and Commissions."

On Wednesday morning Irving E. Moultrop, of the Boston Edison Co., was announced to read a paper on "What the Stoker User Wants from the Stoker Manufacturer." In Mr. Moultrop's absence the paper was presented by R. E. Dillon, of the same company. We hope to present it in a later issue.

The report of the Commercial Committee, of which Frank Bigelow is chairman, presented reports from G. A. Sacchi on traffic, W. H. Rea on statistics and P. A. Poppenhusen on publicity. S. A. Armstrong, chairman of the subcommittee on Revision of Constitution and By-laws, submitted a new draft. A suggestion was made that a division of the committee on Foundry Practice be established.

The members' Championship Golf Tournament scheduled for the afternoon being impossible on account of rain, the program scheduled for Thursday forenoon was continued on Wednesday afternoon. It began with a report from the Engineering Committee, of which John Van Brunt is chairman, dealing with the Boiler Test Code of the A. S. M. E. Exchange of information between boiler and stoker manufacturers, standardization of height of opening in boiler fronts, etc.

L. R. Stowe, chairman of the Conference Committee, with the Power Test Code Committee of the A. S. M. E., presented suggestions that his committee had prepared for submission to the A. S. M. E. committee, but after discussion they were recommitted.

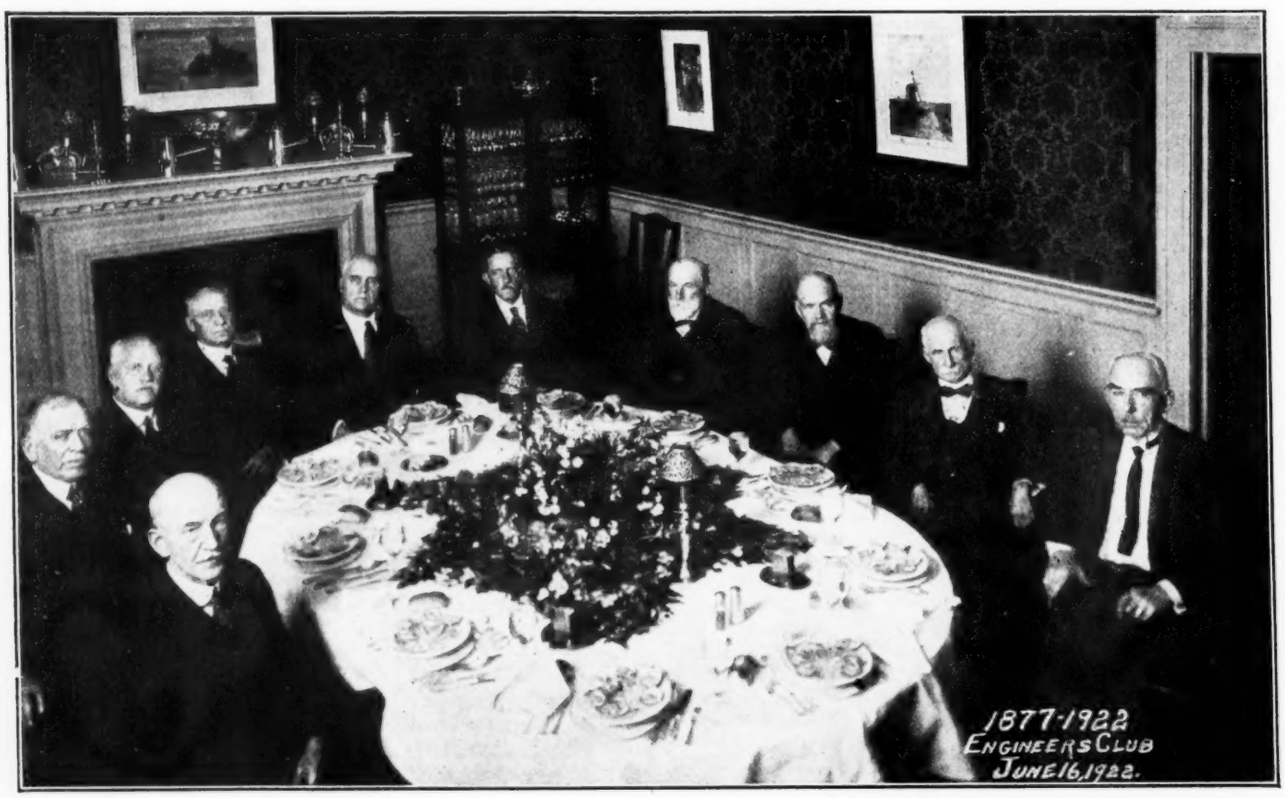
The joint committee of the Stoker Manufacturers' and the American Boiler Manufacturers' Associations, A. H. Blackburn, chairman, submitted blank forms for the exchange of data between stoker and boiler manufacturers.

The election of officers for the coming year resulted in the choice of S. A. Armstrong, president; R. D. Hatton, vice-president; R. B. Mildon, treasurer; P. A. Poppenhusen, executive committee. J. G. Worker was chosen secretary.

Stevens Class of '77 Still Here 100 per Cent

One hundred per cent attendance at its forty-fifth annual class reunion is the proud record hung up by the ten members of the graduating class of 1877 of Stevens Institute of Technology, of Hoboken, N. J., at a dinner held May 16, during Commencement Week, in the Engineers' Club in New York City. This class was the fifth in the history of Stevens, and in the four previous classes there were only 31 graduates in all. No other classes except those of comparatively recent years are able to report all members living.

All the members but one of the class of '77 are still actively engaged in engineering work, and it was only a few years ago that Professor Geyer retired. The class is to be congratulated, therefore, for the industrious spirit that has kept its members at work so long and for the school spirit that brings them all together to renew the memories of their alma mater.



EVERY MEMBER PRESENT FORTY-FIVE YEARS AFTER GRADUATION

Reading around the table from left to right: F. E. Idell, Franklin Van Winkle, Edward P. Roberts, Louis H. Nash, James B. Pierce, John Rapelje, Professor W. E. Geyer, Edward A. Uehling, Morris I. Coster, Alexander G. Brinkerhoff.

Connecticut N. A. S. E. Convention Well Attended

The twenty-seventh annual convention of the Connecticut State Association of the N. A. S. E. was held at New Haven on June 23 and 24, with headquarters at the Garde Hotel. The attendance of delegates was unusually large and almost every association in the state was represented. The meetings were held at the Mason Laboratory of Mechanical Engineering of Yale University.

On Friday afternoon there was an interesting bowling match at the Yale Alleys between the delegates and supplymen; the engineers won easily.

At eight o'clock on Friday evening the opening exercises were held, with State President B. M. Doyle in the chair. In a brief speech Mr. Doyle congratulated the state association on the large attendance, told of the many important subjects to be brought before them for discussion and then introduced Prof. H. L. Seward, of the Sheffield Scientific School. Mr. Seward outlined the class of studies that were being taught at the institute and showed some interesting diagrams on the blackboard. At the close of his address he invited the company to the mechanical laboratory, where several modern devices were inspected, among them an optical indicator in operation. After the necessary committees were appointed, an adjournment was taken until Saturday morning.

On Friday night a smoker was given at the Garde Hotel, where a musical and literary program was rendered and refreshments were served.

An illustrated lecture by Mr. Powell, of the General Electric Co., took place at two o'clock on Saturday afternoon, after which visits were made to the Harkness Memorial Building and to the plant of the Hygienic Ice Co. The convention concluded with a shore dinner at Savin Rock.

State officers were elected as follows: F. C. Sutorius, president, New Haven; Herman Offinger, vice-president, Meriden; Louis Vander Dyk, secretary-treasurer, Waterbury; George F. Klopfer, assistant secretary, New Haven; P. Brosnahan, conductor, Waterbury; Lawrence Blakely, doorkeeper, Hartford; Albert Williams, trustee, Norwich.

Fatigue of Metals

Failure of materials under comparatively light shocks or reversals of stress has long remained a matter of judgment or speculation. Recently, however, this subject has been approached on the basis of tests and exact calculation.

An article by C. E. Stromeyer, O. B. E., Chief Engineer, Manchester Steam Users Association for the Prevention of Boiler Explosions, read at Cardiff, Wales, May 25, 1922, before the South Wales Institute of Engineers, deals with the testing machine recently constructed for further investigating this law, as well as the field to be covered and results anticipated.

In 1914 the author of this article proposed an empirical formula, which checked with a series of fatigue tests that had been published in 1871.

Some practical results of fatigue law, as the article points out, are as follows:

1. A series of curves has been plotted from which the fatigue conditions of different kinds are illustrated, and strength requirements for known conditions may be visualized.

2. A factor of safety for some conditions, can be determined accurately, in contrast to the previous method of approximate choice.

3. There is a well-defined limit between repeated stresses that will cause failure and those that will allow an infinite repetition. A slight change in dimensions will often furnish the cure for a series of failures of a machine element, making extensive designing and testing unnecessary.

4. Since this law has been formulated, the whole range of fatigue phenomena can be determined from a few simple tests, whereas exhaustive tests and plotting of results were originally required.

5. Results indicate that the law is equally good for all kinds of metals, heat-treated or otherwise, but the unexplored region is too great to allow definite calculation in all branches.

6. The effect of time element in applying fatigue is, in many ways, practically an undetermined factor.

The formulated law of fatigue for alternating stresses is

$$S = Fl + C\left(\frac{10^6}{n}\right)^{\frac{1}{2}}$$

in which

S = Alternating stress that will cause failure;
n = Number of times this must be applied to cause failure;
C = A constant depending on material;
Fl = The fatigue limit in tons per square inch or other convenient unit, in which the equation is handled.

The last-named quantity is derived from observation of phenomena of fatigue. It is known that if alternating stresses of proper amount are applied, the metal will eventually reach a state where it becomes heated, and certain molecular changes take place, which increase the ultimate strength, or in other words the stress per unit area, which is required to break it is raised. The ultimate breaking strength, which has been thus increased, is referred to as the "fatigue limit."

This limit depends on loading conditions. If there is no permanent load, and an alternating stress such as tension and compression, is applied, which is slowly increased from zero to the point where heating occurs, Fl will be found to have a higher value than if a permanent load is applied, while the alternating stresses are being increased up from zero. This law is

$$Fl = \frac{Fl_0\ (T - P)^2}{T^2}$$

where

Fl_0 = Fatigue limit with no permanent load, in convenient units;
T = The ultimate strength figured from contracted area after breakage;
P = Permanent stress.

This formula has not been thoroughly investigated experimentally.

The law of fatigue, formulated for all tension and compression conditions, exclusive of time factor is

$$S = [P + Fl_0\left(1 - \frac{P^2}{T^2}\right) + KTM] \div (1 + KM)$$

where

S = Sum of permanent and calculating stresses;
K = A constant;
$M = \left(\frac{10^6}{n}\right)^{\frac{1}{2}}$

For a sample of iron whose tests check with this formula,

$$S = [P + 7\ \left(1 - \frac{P^2}{676}\right) + 7.8\ M] \div (1 + 0.3\ M)$$

The testing machine, which is now available, tests three samples at one time, in tension, bending and push-pull stresses. Any desired permanent stress can be applied, and the alternating stresses can be gradually raised until heating indicates reaching the fatigue limit.

The sample is allowed to cool after its fatigue limit is reached, and then a breaking fatigue test is made. These two tests are sufficient to determine the constants in the fatigue formula first described. Other tests, of course, are desirable in order to try the accuracy of the formula in its complete form and various applications.

The Southern California Edison Company of Los Angeles was recently authorized by the California Railroad Commission to build a new plant to be known as Big Creek Power House No. 3, as a part of its Big Creek hydro-electric development. At first only two units of about 25,000 kw. each will be installed, but the ultimate capacity is to be 150.000 kw.

Big Attendance at Niagara Falls A.I.E.E. Convention

With an attendance of 650 (100 per cent more than expected), a well-planned program and enthusiastic discussion, the American Institute of Electrical Engineers held a successful annual convention from June 26 to 30 at Niagara Falls, with headquarters in the Clifton Hotel.

The Queenston-Chippawa development of the Hydro-Electric Power Commission of Ontario came in for a large share of attention. It was the subject of an extensive symposium on Tuesday, consisting of a number of papers dealing with the development as a whole and with outstanding electrical and mechanical features. Wednesday afternoon was set aside for an inspection of the plant, which, it will be recalled, was described in *Power* for last week.

The increasing importance of local section activities was shown by the allotment of Monday, before the convention had formally opened, to a conference of section delegates. It was voted to follow the same practice at future annual conventions. One of the results of the meeting was a decision that no restrictions be placed on section funds and that sections be allowed to act without permission of the board of directors of the Institute in local matters not involving Institute policy. It was brought out that nearly every section had obtained the best results by having a program with but one subject and one speaker, and that personal appeals from friends were the most effective means of obtaining speakers.

The president's address, followed by an informal reception and dance, was given Tuesday evening. President McClellan took as his topic, "Why Does the A. I. E. E. Exist?" His answer was that one of the best reasons was to give members opportunities for social gatherings like this convention, but that the big reason was to bring electrical engineers together, regardless of their commercial connections, thus keeping alive and untainted the professional spirit of electrical engineering. "What is this professional spirit?" he asked. "It is integrity of purpose, honesty of effort; in short, it is typical of that which is at the bottom of our country's life. We must build even better in the future."

In an address of welcome to the convention on Tuesday morning A. Grier Monroe, president of the Canadian Niagara Power Co., said that electricity has aided in cementing the friendship between Canada and the United States, that much energy is still available at Niagara Falls and that a larger program for future developments is under way. President McClellan, responding, said that the members felt no sense of being in a foreign country, because of the similarity in problems, sentiments and history.

A. P. M. Fleming brought to the convention a greeting from the Institution of Electrical Engineers and other British engineering organizations.

President-elect Jewett outlined a progressive policy for the Institute during the coming year, after which two parallel technical sessions were held.

Canada's Pulp and Paper Industry the Result of Cheap Water Power

The pulp and paper industry of Canada is an interesting example of the industrial activity that follows upon the development of an abundant supply of cheap power. The industry owes its present commanding position in Canada probably as much to the country's tremendous supply of available water power as it does to the forests from which it obtains its raw materials. The problem of cheap and plentiful power is almost as important in the pulp and paper industry as the all-important problem of raw materials; few other industries use so large an amount of power per dollar of product. Coal is a scarce and costly product in Canada, and so all industries obtain their power almost entirely from the so-called "white coal," or water power.

The total installed waterwheel capacity of Canada is estimated to be 2,763,000 hp.; of this amount, 2,013,000 hp. is in central stations, 476,000 hp. in pulp and paper mills, and 274,000 hp. in all other industries combined. Comparison of the amount of power used by the pulp and paper industry as compared with that of all other industries shows its importance, and the fact that in 1920 the industry had a steam-power installation of only 62,400 hp. shows its dependence upon water power.

The dependence of the industry upon water power is further illustrated by a recent announcement that an electric steam generator, designed to use 25,000 kw., has been installed at the plant of the Laurentide Paper Co., in the Province of Quebec. It is reported that this generator is averaging 34,000 kw. and is producing 100,000 lb. of steam per hour, at 125 lb. pressure. The manufacturer, the Electric Furnace Construction Co., of Philadelphia, states that this is the largest electric steam boiler ever built.

Of the 476,000 hp. in waterwheels in the pulp and paper industry, 297,000 hp. represents direct-drive installations, while 179,000 hp. represents hydro-electric drive, the energy in that case being turned into electricity before being applied. In addition, however, the industry purchases 161,000 hp. from hydro-electric plants, so that its total use of water power is 637,000 hp.

It should be noted from the figures given in the preceding paragraph that electric power is used extensively, even in cases where the power is produced by the same company that uses it. The total of the hydro-electric power that is produced and purchased by the industry (339,000 hp.) is considerably greater than the capacity installed with direct drive. It is felt by many that the time for direct connection of waterwheels and generators in that industry is past—that the modern way is to develop the power as a hydro-electric project and locate the mill at a point more suitable from the operating and shipping point of view.

The growth of the pulp and paper industry in Canada is often brought out vividly by comarison between the amount of export trade recorded for 1890 ($120) and the present figure, which is over $100,000,000. In 1920 the industry represented a total capital investment of $347,553,333, and provided employment for 31,298 people, whose yearly wages and salaries amounted to $45,253,893; the total value of product was $214,421,546.

Employer's Liability for Defective Boiler

By Arthur L. H. Street

The Washington Workmen's Compensation Act provides that if injury results to an employee from "deliberate intention of his employer to produce such injury," the workman may not only recover an award under the act, but may also sue the employer for damages. In the case of Delthony vs. Standard Furniture Co., 205 Pacific Reporter, 379, plaintiff showed that while employed near a boiler maintained by defendant in the building occupied by the company he was injured through explosion of the boiler. He had recovered $777 under the Compensation Act and sued for additional damages under the provision referred to. He contended that defendant had previously known of the defective condition of the boiler and yet continued to use it in the defective condition, and that this constituted deliberate intention. But, affirming a judgment dismissing the suit, the Washington Supreme Court said:

It will be noticed that before the appellant would be entitled to recover it would be necessary for him to allege and prove that his injury was the result of a deliberate intention of the respondent to injure him. There is no evidence in the record showing, or tending to show, any such deliberate intention. It may be admitted that, if the question were one as to whether the respondent was negligent in the manner in which it maintained the boiler, the case would present a question for the jury. The appellate contends that, if the respondent knew of the dangerous and unsafe condition of the boiler, and knowing this fact, if it is a fact, maintained the boiler in a dangerous and unsafe condition, as a matter of law it would be held to have been deliberately intended to produce the injury. But this proposition cannot be sustained. The language of the act is "deliberate intention," and evidence of negligence fails to show such intention.

News in the Field of Power

$7,500,000 Ready for Muscle Shoals Oct. 1.

By a vote of 145 to 105, the House of Representatives on June 24 agreed to concur in the Senate amendment to the War Department appropriation bill, thus appropriating $7,500,000 for the reopening of construction work on the Wilson Dam at Muscle Shoals. The vote carried with it, however, approval of an amendment by Representative James, of Michigan, which provides that no portion of the $7,500,000 is to become available before October 1; the purpose of this amendment was to give additional time for Congress to pass definitely on the Ford offer. The amendment was actively supported by those favoring the Ford offer, who saw in the Senate amendment an effort to delay action on the Ford proposition.

Representative Huddleston, of Alabama, declared that the Senate amendment is anti-Ford. "We know," he said, "that the real object in view is to kill the Ford offer and then turn Muscle Shoals over to the Alabama Power Company or some other exploiting interest."

The more generally accepted view, however, was that the appropriation is not inconsistent with the Ford or any other offer. The House amendment providing for holding up the appropriation until Oct. 1 was later approved by the Senate against considerable opposition.

Hoover Testifies on Colorado Bill

Secretary Hoover testified at some length recently before the Committee on Arid Lands of the House of Representatives on the utilization of the waters of the Colorado River and the construction of the Boulder Canyon Dam. This committee is conducting hearings on the Swing Bill, which, among other things, appropriates $70,000,000 for the Colorado development.

Mr. Hoover said that the Colorado River Commission, of which he is chairman, is now working on the problem of settling the interstate rights to the water, and that it will doubtless offer some recommendation as to "a long view program for the development of the river." No agreement has been reached as yet, however, and the Commission will reassemble Aug. 1 at Santa Fe to consider the matter further.

Mr. Hoover felt confident that the members of the Commission are fairly well agreed as to the first step in the development, which would be the construction of a large dam somewhere near Boulder Canyon, although the location might be changed some 15 or 20 miles in either direction by some questions of foundation.

He did not think that there was any real dispute over the power question, and pointed out that, since the maximum development of the river will produce 5,000,000 or 6,000,000 hp., the production of 500,000 or 600,000 hp., at Boulder Canyon is not by any means the ultimate limit.

His favorable attitude toward the bill was shown by this statement: "I think this legislation should go forward, because the emergent situation in the Imperial Valley requires almost immediate action in the control of the river."

As to the cost of the project he said: "The Boulder Dam will cost in the neighborhood of $40,000,000, perhaps. My offhand impression is that 200 years hence, when we will have developed all the land that can be developed by the river, we will have spent $400,000,000."

Reform—not Compromise—Cure for Coal Troubles

Clear up the economics of the coal business, and a lasting settlement of labor controversy would become a possibility; leave these questions unanswered, and industrial peace cannot be expected to survive the usual two-year armistice.

What coal producers and coal consumers alike need is reform of the business rather than compromise between parties to the controversy, and in this reform it is absolutely essential that the mine worker should co-operate with the mine operator. Too long have the mine owners treated the coal business as private privilege, and too long have the labor leaders with no less monopolistic attitude obstructed every move for underground efficiency and economy. The people's coal costs too much because of the mistaken idea that mine owner and mine worker can continue to fight over contracts and rules. Cheaper coal and larger earnings will come when engineering is emphasized more and bargaining less.

—From a recent speech by Dr. George Otis Smith, Director of the Geological Survey.

Fritz Medal Goes to Marconi

The 1922 John Fritz Medal has been awarded to Senator Guglielmo Marconi for the invention of wireless telegraphy. Senator Marconi was recently the principal speaker at the Engineering Societies Building in New York City, when the auditorium was crowded to capacity and many were turned away, and he will come before an engineering audience again at the same place on July 6, when the medal will be formally presented to him.

Train Engineers To Be Leaders, says Professor Scott

That the education of an engineer should give him not only an understanding of technical problems, but also such an understanding of the relationship of engineering to the economic development of the country's resources as to qualify him for positions of industrial leadership, was the keynote of an address delivered by Prof. Chas. F. Scott, of Yale University, as president of the Society for the Promotion of Engineering Education at its annual convention held recently at the University of Illinois.

Prof. Scott pointed out that all basic industries are looking not only for trained technicians, but for leaders of production and administration, and that before the engineering university can develop in the engineer the qualities necessary for this leadership a change must be made in the methods of engineering education. His principal recommendation was that methods should be developed for finding out more about the qualifications of students, and for adapting the training to meet their needs, instead of giving them more or less uniform treatment as at present.

He pointed out that materials in industry are carefully tested and selected for the work that they are to do, and that the universities could well adopt a similar idea by giving greater attention to the particular needs of industry and to the qualifications of each student, and by adapting educational methods to those two factors.

He felt that the first step in accomplishing these objects would be the building up of efficient teaching staffs, and recommended that the Society direct its efforts toward that end. This thought was embodied in a resolution adopted by the Society, which empowered the president to appoint a committee of five to study the question "What can the Society do in a comprehensive way to develop, broaden and enrich engineering education?"

Considerable interest and discussion were aroused by an explanation by Dean A. A. Potter, of Purdue University, about the plan of instruction for freshmen inaugurated by him. This plan is designed particularly to stimulate the interest of the student early in his course by introducing engineering problems that appeal to his instincts, and that deal with actual situations calling for quick and accurate solution.

Plans for the construction of a 200,000-hp. hydro plant at Auburn, Cal., for the American River Water and Power Co. have been completed. The estimated cost of the project is $18,000,000.

Coosa River Plans Changed

The Alabama Power Company's license covering its development at Duncan's Riffle on the Coosa River has been amended at the request of the company by the Federal Power Commission to provide for the early installation of three units instead of two and the future installation of one additional unit. The amendment makes provision for a flume in the west abutment of the dam which is to lead to a future unit to be installed on the west bank down stream from the dam. This modification in the original plan is in accordance with the requirements of the machinery manufacturers.

Another Pacific Coast Trip

Alfred D. Flinn, secretary of the Engineering Foundation and chairman of the Division of Engineering of the National Research Council, is the latest engineer to take up the idea of a "swing around the circle" for the promotion of engineering interests. Like President Kimball, of the A. S. M. E., Mr. Flinn will concentrate on the Pacific Coast and plans to visit a number of cities from Los Angeles up to Canada, returning through the latter country to Chicago. Mr. Flinn will go as the representative of organized research and will endeavor to enlist the aid of engineers in the far West in a nation-wide plan of industrial research.

Diesels in Palestine

A 1,000-kw. electric power station using Diesel engines is now under construction at Jaffa, on the Palestine shore of the Mediterranean, and will probably be completed by the end of the present year. Two additional Diesel plants are to be put up at Haifa and at Jerusalem. The ultimate plan is to use these three stations for peak-load service in connection with a large hydro-electric system centering in the valley of the River Jordan. This is the beginning of a tremendous water-power development program for which concessions have already been granted by the Palestine government, and which involves practically the entire water resources of the country. The main use for the power is irrigation, on account of the long dry seasons.

O. K.'s Drilling Navy Oil Reserves

Government leases for drilling on naval oil reserves to prevent their drainage by outside wells was justified in testimony by Secretary of the Navy Denby before the Senate committee on appropriations in consideration of the Naval appropriation bill. He estimated that Naval Oil Reserve No. 1 in California contained 130,000,000 barrels of oil, Reserve No. 2 in California 125,000,000 barrels and Reserve No. 3 in Wyoming from 30,000,000 to 60,000,000 barrels. He said the Navy plans to store the oil for emergency and not to use it for current purposes, although it has not yet been decided what shall be done with oil developed on the reserves in excess of proper war reserves. It was stated that the war reserves will probably not be placed in storage for two years.

Two More Permits Granted

The Federal Power Commission has granted the application of the Southern Sierras Power Co., of Riverside, Cal., for a preliminary permit to extend for two years, covering a power project on the White Water River in San Bernardino and Riverside Counties, California. A similar application by Marcus Pluth, of Los Angeles, was denied. The project involves the construction of three power houses with auxiliary works, which are to be connected with the system of the company which extends from Mono Lake to Imperial Valley.

A preliminary permit for a period of three years has been granted to the Washington Water Power Co. of Spokane, Wash., to develop power at Kettle Falls, Idaho. The company proposes to make the development in three stages. The ultimate stage is to provide a 75 ft. head developing 153,000 hp. The permit carries with it the requirement that the company shall provide in its plans for the construction by the United States at some future date of locks and navigation facilities at the dam. The company is required to design its works so as not to interfere with any existing portage at Kettle Falls.

Coming Conventions

National Association of Stationary Engineers; Fred W. Raven, 417 South Dearborn St., Chicago, Ill. Annual conventions and exhibitions of the State Associations scheduled as follows:

New England, at Springfield, Mass., July 12-14; James Morgan, 53 Devonshire St., Boston.

Michigan, at Kalamazoo, July 19-21; A. M. Adams, 1307 Stockbridge Ave., Kalamazoo, Mich.

Wisconsin, at Madison, July 26-28; C. Z. Wise, 204 South Carroll St., Madison.

Minnesota, at Minneapolis, Aug. 9-11; C. A. Nelsen, 800 22nd Ave., N. E., Minneapolis.

Iowa, at Des Moines, Sept. 10-11; Abner Davis, Room 16, Waterhouse Block, Cedar Rapids, Iowa.

Universal Craftsmen Council of Engineers; Thomas H. Jones, 33 Linden Ave., Cherrydale, Va. Annual convention and exhibition at Cleveland, Aug. 7-11.

Personals

A. G. Christie, Professor of Mechanical Engineering at Johns Hopkins University, is with the engineering and construction firm of McClellan and Junkersfeld, Inc., of New York City, for the summer months. Prof. Christie is engaged in research work in connection with certain power-plant equipment and in specialized heat balance studies.

A. B. Neumann has opened offices as a consulting engineer in the Peoples Gas Bldg., 122 South Michigan Ave., Chicago. He has lately been engaged in making appraisals of steel, power and manufacturing plants, and for the last three years has been chief consulting engineer for the Steel & Tube Co. of America. He designed and built the Gary plant of the U. S. Steel Corporation and other notable plants.

Dr. M. G. Lloyd, of Washington, chief of the Safety Section of the United States Bureau of Standards, has been elected to the board of directors of the Eyesight Conservation Council of America, with headquarters in New York. He is vice-president of the American Society of Safety Engineers, and will take part in a national movement for eye conservation, which has been started by the Council.

W. Woodward Williams has resigned as vice-president of the Pittsburgh Gage and Supply Co. to join the Titan Iron and Steel Co., Inc., Newark, N. J., in the same capacity. Back in 1914 he was general manager of sales for the A. M. Byers Co., later becoming general manager, and in 1919 he became general manager of the Reading Iron Co., afterward being elected vice-president.

Fuel Prices

FUEL OIL

New York—June 29, Port Arthur light oil 22@25 deg. Baumé 3¾c. per gal.; 30@35 deg., 4¾c. per gal. f.o.b. Bayonne, N. J.

Chicago—June 24, for 24@26 deg. Baumé, $1.15 per bbl.; 21@36 deg., 3½c. per gal. in tank cars, f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—June 26, f.o.b. refinery, Pennsylvania, 36@40 deg., 5c.; Kentucky fuel oil, 26@30 deg., 3¾c. per gal. Gas oil, 32@34 deg., 3c. per gal.; 36@38 deg., 3¼c.; 38@40 deg., 3½c. Western, 24@30 deg., $1.35 per bbl.

Philadelphia—June 26, 26@28 deg. Baumé, Oklahoma, $1.05@$1.10 per bbl.; 30@34 deg., Oklahoma (group 3), 3@3¼c. per gal.; 16@20 deg. Seaboard, $1.15@$1.25 per bbl.

Cincinnati—May 27, for 26@30 deg. Baumé, 5½c.; Diesel 32@24 deg., 5¼c. per gal.; distillate 39@40 deg., 6c.

Cleveland—May 27, 26@30 deg. Baumé, 4¾c. per gal.

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run bases, f.o.b. mines):

Coal	Market Quoting	June 19, 1922	June 26, 1922
Pool 1,	New York	$4.25–4.50	$4.40–4.50
Smokeless,	Columbus	3.25–3.40	3.35–3.50
Clearfield,	Boston	2.85–3.25	3.15–3.40
Somerset,	Boston	3.00–3.40	3.35–3.50
Kanawha,	Columbus	3.15–3.35	3.25–3.50
Hocking,	Columbus	3.00–3.25	3.40–3.50
Pittsburgh No. 8	Cleveland	3.60–3.75	3.75–4.00
Franklin, Ill.,	Chicago	.....	.....
Central, Ill.,	Chicago	.....	.....
Ind. 4th Vein,	Chicago	.....	.....
West Ky.,	Louisville	3.65–3.90	4.00–4.15
Big Seam,	Birmingham	1.75–2.00	1.85–2.00
S. E. Ky.,	Louisville	3.00–3.50	3.25–3.50

New Plant Construction

PROPOSED WORK

Ala., Dothan—The city, E. O. Jones, Mayor, City Hall, will receive bids until Aug. 15 for hydro-electric project, at High Bluff on the Choctawhatchee River, consisting of construction of dam, spillway, power house, furnishing and installing turbines, generators, transformers, auxiliary power house equipment for a present installation of approximately 3,000 b.hp. capacity in 2 units; also 21½ mi. transmission line 44,000 volts pressure. The Ludlow Engineers, Inc., Winston-Salem, N. C., Engrs. Noted May 3, 1921.

Cal., Lakeport—The city is having plans prepared for waterworks system, including auxiliary pumping plant, semi-Diesel pumping engine, etc., estimated cost $65,000; also 3 septic tanks including automatic pump for sewage system, estimated cost $22,000. J. Felleman Engr.

Cal., Livermore—The U. S. Veterans' Bureau, Room 1044, Arlington Bldg., Wash., D. C., is having plans prepared for 30 rein.-con. and frame hospital buildings on Cresta Blanca, 5 mi. from here. Estimated cost $2,000,000. M. O'Brien, 68 Post St., San Francisco, Archt.

Cal., Los Angeles—St. Vincent's Hospital is having plans prepared for 8 story hospital and 3 story, 60 x 200 ft. and 50 x 100 ft. dormitory, including steam heating system, on Sunset Blvd. Estimated cost $450,000. J. C. Austin, Baker-Detwiler Bldg.

Cal., Merced—The Stevenson Corp., 68 Post St., San Francisco, plans irrigation system, including 57,700 ft. ditches, 500 ft. wood stave, three 24 in. centrifugal pumps, 25 ft. lift, 450 hp. motors.

Cal., Vernon—The city is having preliminary plans prepared for water system consisting of reservoir 3,000,000 gal. capacity, 3 centrifugal pumps, motor driven turbine pump 1,500 gal. per minute under 125 ft. head, well, gate valves, mains, etc. Estimated cost $450,000. H. McCurdy, 335 Pacific Elec. Bldg., Los Angeles, Engr.

Conn., Manchester—The Manchester Water Co. is having preliminary plans prepared for dam with 22 ft. spillway at reservoir, retaining walls, etc. Estimated cost over $25,000.

D. C., Washington—The Burlington Hotel Co., 1120 Vermont Ave., N. W., is having plans prepared for apartment hotel. Estimated cost $460,000. Sonneman & Justeman, Davidson Bdg., Archts.

Fla., Homestead—The town council, S. E. Livingston, Mayor, will receive bids until July 28 for electric light plant, including 2 steam turbo-generator sets 300 kw., 3 phase, 60 cycle, 2,300 volt, one 10 panel switchboard, two 150 to 200 hp. boilers, etc. B. M. Duncan, Engr. Noted June 13.

Ill., Bunker Hill—The *Gazette News* is in the market for 500-2,000 r.p.m. cycle, single phase motor, etc., for Chandler 2 piece press.

Ill., Chicago—The Cedar Building Corp., c/o Marshall & Fox, Archts., 721 North Michigan Blvd., is having plans prepared for 10 story, 130 x 140 ft. apartment building, including steam heating system, on 20-28 East Cedar St. Estimated cost $500,000.

Ill., Chicago—N. M. Dunning, Archt., 310 South Wabash Ave., is preparing plans for 6 story addition to Hotel Hayes, University Ave. and 64th St. Estimated cost $1,000,000.

Ind, Bloomington—The City Council plans to build a dam to connect with present water system. Estimated cost $140,000. U. S. Hanna, City Engr.

Ind., Michigan—The Sullivan Machinery Co., 122 South Michigan Ave., and A. S. Coffin, Archt., 39 West Adams St., are receiving bids for two 2 story, 60 x 400 and 400 x 550 ft. factory buildings. Estimated cost $1,000,000.

Me., Pejepscot—The Pejepscot Paper Co., Brunswick plans to build extensions to paper mill here. Estimated cost $1,000,000. Architect not yet appointed.

Md., Annapolis—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., plans deferrization plant, high power radio station, here. Spec. 4682.

Md., Baltimore—S. T. Williams, 223 North Calvert St., is in the market for 500 to 1,000 kw. turbine generator unit, 3 phase, 60 cycle, 220 volt; cableway about 600 ft. with electric hoisting engine; also condenser.

Mich., East Lansing—The Michigan Agricultural College, H. H. Halladay, Secy., will soon award the contract for 3 story addition to Home Economics building, including steam heating system. Estimate cost $250,000. E. A. Boyd, 127 West Allegan St., Lansing, Archt.

Mich., Houghton—School District No. 1, W. F. Miller, Secy., will receive bids until July 15 for 3 story high and grade school. Estimated cost $400,000. Van Leyen, Schilling, Keough & Reynolds, 3440 Cass Ave., Detroit, Archts. Noted June 13.

Mich., Plymouth—The Detroit House of Correction, J. O. Stutzman, Supt., 1441 Alfred St., Detroit, will receive bids until July 10 for 3 story 76 x 420 ft. administration, 1 and 2 story, 408 x 840 ft. industrial, 3 story, 32 x 328 ft. cell block buildings and 1,500 kw. power house, two 750 hp. steam turbines, 2 boilers, conveyors, car system, transformers, 3 heating system circulating pumps, fire pump, 25 ton refrigerating machine, etc. Estimated cost $2,500,000. A. Kahn, 1000 Marquette Bldg., Detroit, Archt. Noted Sept. 13, 1921.

Minn., North St. Paul—The city is having plans prepared for extensions to waterworks, including electrification of pumping plant. Estimated cost $60,000. Toltz, King & Day, 1410 Pioneer Bldg., St. Paul, Engrs.

Minn., St. Paul—The State Bd. of Control, D. F. Mullen, Secy., The Capitol, is in the market for electric crane and air compressors to equip new mines experiment station. Chas. L. Pillsbury Co., 1200 2d Ave. South, Engrs.

Minn., West Concord—The city is having plans prepared for waterworks extensions, construction of a pump house and electrification of pumping plant. Estimated cost $35,000. Toltz, King & Day 1410 Pioneer Bldg., St. Paul, Engrs.

Miss., Starkville—The State Bond Improvement Comn., Jackson, will receive bids until July 8 for furnishing and installing steam and water piping system in the power house at the Agricultural College, here. T. C. Link, Jackson, Super. Archt.

Neb., Lincoln—Sanitary District No. 1 of Lancaster Co., W. C. Israel, Secy., received bids for pumping equipment for sewage disposal plant from McCulley, Widener & Wright, 919 W. O. W. Bldg., Omaha, $9,176, Kent Engineering Co., Omaha, $10,000, Beeson Machinery Co., 308 Mutual Bldg., Kansas City, Mo., $10,700. Alvord, Burdick & Howson, Hartford Bldg., Chicago, Ill., Engrs. Contract for building awarded to A. Phelps & Sons, Knoxville, Ia., $138,075. Noted June 6.

N. J., Gloucester—A. W. Grant, Harrison Bldg., will soon receive bids for 1 and 2 story, 100 x 500 ft. factory building for manufacturing Diesel engines. Estimated cost $500,000. A. W. Akenoff, Harrison Bldg., Phila., Pa., Engr.

N. J., Maplewood—The South Orange Bd. Educ., South Orange, plans to build a high school on Academy St. and Parker Ave. here. Estimated cost $500,000.

N. J., Newark—Guilbert & Bettelle, Archts. and Engrs., 2 Lombardy St., will receive bids until July 10 for bank building, for the North Ward Natl. Bank, 445 Broad St. Estimated cost $300,000.

N. Y., Batavia—The Genesee Light & Power Co. plans improvements including extension of service to Newstead, street lighting system in Pembroke, also improvements to sub-station at Attica. Estimated cost $53,700. Engineer not announced.

N. Y., Cohoes—The Supt. Public Works, Capitol, Albany, will receive bids until July 10 for Contract A-1 furnishing and delivering 2 hydraulic turbines with governor equipment; Contract A-2, two water wheel driven generators and equipment in the proposed power house at Crescent Dam.

N. Y., Lewiston—The American Super Power Co., J. B. Scoville, Dir., plans to build a power canal from LaSalle to Lewiston Heights to furnish from 10,000 to 12,000 cu.ft. of water per second, and later plans distribution of power throughout New York State. Estimated cost $10,000.

N. Y., New York—Buchman & Kahn, Archts., 56 West 45th St., will receive bids until July 15 for 3 story addition to hospital building for the Hospital for Joint Diseases, 124th St. and Madison Ave. Noted May 2.

N. Y., New York—The United Hotels Co., 25 West 45th St., is having preliminary plans prepared for 15 story hotel on 45th St. and Madison Ave. Estimated cost $8,000,000. George B. Post & Sons, 101 Park Ave., Archts. and Engrs.

N. Y., New York—The Y. M. C. A., 2 West 45th St., is having plans prepared for 20 story, 75 x 100 ft. Y. M. C. A. building at 333 West 56th St. Estimated cost $1,200,000. J. F. Jackson, 137 East 45th St., Archt. and Engr.

N. Y., Olean—The Niagara, Lockport & Ontario Power Co., Marine Bank Bldg., Buffalo, has acquired the plant of the Olean Light & Power Co. and plans extensive improvements, also plans the construction of 65 mi. transmission line from sub-station at Gardenville. Estimated cost $750,000. Noted May 30.

N. Y., Ransomville—The Rogers Heating Co. is in the market for steam and water boilers, all sizes.

N. Y., Syracuse—George B. Post & Sons, Archts. and Engrs., 101 Park Ave., New York, will receive bids until July 17 for 11 story hotel on Harrison and Warren Sts. for the Syracuse Hotel Corp., Barney Bldg. Estimated cost $2,500,000. Noted Nov. 29, 1921.

N. Y., Syracuse—The Superintendent of Public Works, State Capitol, Albany, will receive bids until July 25 for Terminal Cont. 89, paving a portion of the terminal site, constructing railroad and crane tracks, electrical work, etc., here.

N. C., Belhaven—The town will receive bids until July 19 for 150 kw. Diesel or semi-Diesel crude oil engine generator unit with appurtenances. W. C. Olsen, Kinston, Consult. Engr.

N. C., Charlotte—The Efird Department Store, J. B. Efird, Pres., 47 East Trade St., will soon award the contract for 6 story, 99 x 188 ft. store building on Tryon St. Estimated cost $500,000. L. Asbury, Realty Bldg., Archt.

N. C., Nashville—The city plans 9 mi. transmission line from Rocky Mount here. Mees & Mees, Charlotte, Engrs.

Ohio, Ada—The Ohio Northern University will receive bids until July 10 for 45 x 75 ft. power house. C. C. Carpenter, Engr.

Ohio, Bellaire—The National Bank of Bellaire is having plans prepared for 8 story, 40 x 120 ft. bank and office building on 32nd and Belmont Sts. Estimated cost $400,000. F. F. Farris, Wheeling Steel Bldg., Wheeling, W. Va., Archt.

Ohio, Cleveland—The Studebaker Corporation, E. J. Murane, Sales Dir., 2020 Euclid Ave., will soon award the contract for 3 story, 140 x 148 ft. service building, including steam heating system, on East 25th St. Estimated cost $250,000. W. S. Ferguson Co., 1900 Euclid Ave., Archts.

Ohio, Cleveland—The Tifereth Israel Congregation, c/o H. Silver, East 55th St. and Scovill Ave., have had plans prepared for 2 story temple, including steam heating system on East 105th St. and Ansel Road. Estimated cost $350,000. C. R. Greco, Guardian Bldg., Archt.

Ohio, Cleveland—The Western Reserve University, S. S. Wilson, Secy., 10940 Euclid Ave., and Coolidge & Shattuck, Archts., 122 Ams. Bldg., Boston, Mass., will receive bids until July 12 for 1, 3 and 4 story medical school, power house and animal hospital buildings, including steam power plant, on Adelbert and Abington Rds. Estimated cost $1,750,000. Complete power plant equipment will be required. Noted Feb. 14.

Ohio, Dayton—The Bd. Educ., C. S. Schmidt, Clk., will receive bids until July 13 for 3 story Roosevelt high school. Estimated cost $250,000. Schenk & Williams, Mutual Home Bldg., Archts.

Ohio, Dayton—The National Home for Disabled Volunteer Soldiers, Bd. of Governors, Gen. G. H. Wood, Pres., is in the market for ice making machinery, 25 ton capacity, for the National home in Wis.

Ohio, Painesville—The Lake Erie College for Women plans to build 2 story dormitory and steam power plant. Estimated cost $500,000 A. Garfield, 913 Natl. City Bldg., Cleveland, Archt.

Pa., Mercer—The Mercer Light, Heat & Power Co., plans to rebuild transmission line from sub-station at Fredonia, N. Y. Estimated cost $20,000.

Pa., Phila.—Carson & Carson, Archts., 22 South 15th St., is receiving bids for 10 story, 95 x 191 ft. office and sales building on 30th and Walnut Sts. for the Westinghouse Electric Co., Weidner Bldg. Estimated cost $700,000.

Pa., Phila.—Mastbaum Bros. & Fleitcher, 1424 South Penn Sq., will soon receive bids for 10 story office building on Broad and Pine Sts. Estimated cost $1,000,000. Hoffman-Henon Co., Finance Bldg., Archts.

Pa., Pittsburgh—The Pittsburg & Des Moines Steel Co., Curry Bldg., is in the market for 2 large triplex power pumps.

Pa., Sharon—The Bd. of Educ. is having plans prepared for a new high school. Estimated cost $440,000. Taylor & Hanna, Archts.

Tenn., Knoxville — Duncan Machinery Co., 721 North Central Ave., is in the market for 1 locomotive type boiler, 60-70-80 or 100 hp., 120 lb. steam pressure and 1 tubular boiler on skids. A Duncan, Purch. Agt.

Tenn., Nashville—Caldwell & Co. will soon award the contract for office building. Estimated cost $1,000,000. McKim, Mead & White, 101 Park Ave., New York, Archts. and Engrs.

Tex., McLean—The city plans election July 18 to vote $74,000 bonds for light and power plant, waterworks system, and street improvements.

Tex., San Antonio—The City voted $2,000,000 bonds for the erection of new schools and the improvement of existing schools. Dr. F. Hargis, Pres. Bd. Educ.

Va., Richmond—The News-Leader Publishing Co., 9 North 8th St., is receiving bids for 4 story, 90 x 140 ft., printing plant on 4th near Grace St. Estimated cost $300,000. Baskerville & Lambert, Travelers Bldg., Archts.

Va., Yorktown—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., opened bids for alternators and auxiliary equipment at the Naval Mine Depot, here, (1) work complete from Westinghouse Electric Manufacturing Co., 803 Hibbs Bldg., Wash., D. C., (1) $9,500 (150 days); Electro-Mechanical Co., South Calvert St., Baltimore, Md., (1) $10,147, (2) $9,230; Carroll Electric Co., 714 12th St., Wash., D. C., (1) $11,250 (150 days). Spec. 4612. Noted June 13.

Va., Yorktown—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., opened bids for remodeling and installing 3 Diesel oil engines, here, (1) work complete from American Eng. Co., Aramingo and Cumberland Sts., Phila., Pa., (1) $10,750 (150 days), (2) $1,400; Newport News Iron Works, Newport News, (1) $11,200 (150 days), (2) $1,300; Shevlin Eng. Co., 110 West 34th St., New York, (1) $12,560 (150 days), (2) $1,305. Noted May 9. Spec. 4627.

W. Va., Morgantown—The City plans to issue $750,000 bonds for new sewerage system, including electrical pumping equipment and power plant equipment for same.

W. Va., Wheeling—J. Sentinger, Jr., 1109 Market St., plans to build 15 to 20 story office building on Market St. Estimated cost $1,000,000. Architect not announced.

Wis., Beloit—The B. B. Yates Machine Co., 729 4th St., plans to build addition to power plant, 1,000 kw. generating unit, also remodel present building. Private plans.

Wis., Boscobel—M. Marcus & Sons Co., plans to install new steam heating plant and boiler, in store. Claude & Starck, Badger Annex, Madison, Engrs.

Wis., Sheboygan—The city, J. Steimle, Clk., plans to install 300 hp. boiler and radial stack at the city pumping station. Engineer not selected.

Wis., West Bend—The West Bend Aluminum Co. is having plans prepared for 20 x 80 ft. boiler house, including boilers. Estimated cost $45,000. Federal Eng. Co., 444 Milwaukee St., Milwaukee, Archts.

Wis., Whitewater—The State Normal School Bd., W. J. Kettle, Secy., Madison, will receive bids until July 12 for piping, boiler setting, steam conduit, etc. A. Peabody, Madison, Engr.

Wis., Milwaukee—The American Exchange Bank, Plankinton Arcade, is having plans prepared for 4 story, 70 x 102 ft. bank building on Grand Ave. and 2d St. Estimated cost $500,000. Kirchhoff & Rose, 221 Grand Ave., Archts.

Alta., Chipman—The Chipman Flour Mills Corp. plans to install a light and power plant in connection with their mills.

N. B., St. John—The City Council plans to build a new power and light plant, including distribution system. Estimated cost $850,000-$900,000. Address H. Phillips, engr. in charge, c/o N. B. Contracting Co., St. John. Noted May 16.

Ont., Cornwall—The United Counties of Stormont, Dundas and Glengary, c/o M. W. Beach, Iroquois, has been granted a franchise for transmission line to furnish light, heat and power to the various municipalities.

Ont., North Bay—The Canadian Creostine Co. plans to build a plant for creosoting ties, 200,000 annual capacity. Estimated cost, including machinery, $1,500,000. A. Moore, Chf. Engr.

Ont., Ottawa—The Stadium of Ottawa, Ltd., 198 Sparks St., will soon receive bids for stadium, stores and artificial ice plant for rink, on King Edward Ave. Estimated cost $300,000. Millson & Burgess, Home Bank Bldg., Archts.

Que., Montreal—The Montreal Electrical Comn. will call for tenders for placing conduits in streets west of Bluery to the line of Beaver Hall Hill and East of St. Lawrence St. to Berri St. Estimated cost $250,000.

CONTRACTS AWARDED

Cal., Mare Island—The Bureau of Yards & Docks, Navy Dept., Wash., D. C., has awarded the contract for extension to power house, here, to J. Pringle, 621 Georgia St., Vallejo, $8,800 (120 days). Spec. 4664.

Cal., San Leandro—The Bd. Supervisors of Alameda County has awarded the contract for 1 story power house and laundry buildings on County Infirmary site to M. E. Hopper & Sons, 1117 Webster St., Oakland, $122,545. Noted May 2.

Ia., Des Moines—The Liberty Building Co. has awarded the contract for 12 story office building on 6th and Grand Aves. to J. A. Benson Constr. Co., 422 Valley Natl. Bank Bldg. Estimated cost $1,000,000.

Ill., Chicago—Shea-Smith & Co., 322 Federal St., has awarded the contract for 4 story 86 x 150 ft. printing plant, on West Congress and Ashland Ave. to J. W. Snyder & Co., 122 South Michigan St. Estimated cost $250,000. Steam heating system will be installed.

Kan., Andale—The city clerk has awarded the contract for installing 20 mi. of transmission line including distribution system for three towns to D. Chapin, Jr., 1806 East 29th St., Kansas City, $33,006. Noted June 20.

Kan., Atchison—Pillsbury Flour Mills Co., Metropolitan Life Bldg., Minneapolis, Minn., has awarded the contract for 72 x 148 ft., 180 ft. high additional unit, including grain elevator, transformer house and offices to Fegles Constr. Co., 7th St. and 1st Ave. N., Minneapolis, Minn. Estimated cost $225,000.

Mass., Lawrence—The American Woolen Co., 245 State St., Boston, has awarded the contract for 6 story, 100 x 500 ft. mill building, including steam heating system, at Washington Mills plant to the Turner Constr. Co., 178 Tremont St., Boston. Estimated cost $500,000. Noted Mar. 21.

Mich., Detroit—The Woodward Larned Realty Co., c/o C. H. Crane, Archt., Huron Bldg., has awarded the contract for 10 story office building, including steam heating system, on Woodward Ave., to A. W. Kutsche, 535 Griswold St., about $400,000. Noted Apr. 11.

Minn., Minneapolis—The Fulton Bag & Cotton Mills, c/o V. C. Douglas, 643 Security Bldg., has awarded the contract for 4 story factory and office building on East Hennepin Ave. and Taft St. to H. N. Leighton Co., 127 South 10th St., about $230,000. Steam heating system will be installed. Noted Mar. 28.

Neb., Beaver City—The city has awarded the contract for rebuilding power plant to W. Jones; furnishing 75 kva. generator, 5 and 20 hp. motors, two 7½ kva. transformers, 4 panel switchboard, to Western Electric Co., 802 Farnum St., Omaha, $3,800; one 60 kva. generator to Fairbanks Morse Co., 902 Harney St., Omaha, $1,400; installing equipment to Hackett & Cooper, Bankers Life Bldg., Lincoln.

Neb., Humboldt—The O. A. Cooper Mills has awarded the contract for a mill, elevator and power plant, to Birchard Constr. Co., Terminal Bldg., Lincoln. Estimated cost $50,000.

Neb., Lawrence—The city, F. Rischling, Clk., has awarded the contract for distribution and transmission systems to Hackett & Cooper, Bankers Life Bldg., Lincoln, $13,310. Noted May 30.

N. J., Trenton—The City Commission has awarded the contract for pumping plant, including Ames Una-flow engine root rotary pump, electric generator condenser, etc., to H. E. Stahl, Goodwill Pl., $57,989. Noted June 6.

N. Y., Batavia—The Bd. Educ. has awarded the contract for 3 story, 144 x 200 ft. school on Ross St., to Baur & Mack Contracting Co., Niagara Falls, $385,420. Noted May 30.

N. Y., Brooklyn—S. Ageloff, 26 Court St., will build 2 story, 110 x 200 ft. office building on DeKalk and Flatbush Ave. extension. Estimated cost $300,000. M. Klein, 37 Graham Ave., Archt. and Engr. Owner will build.

N. Y., Buffalo—The Genessee Properties, Inc., S. Weed, 95 Swan St., Judge L. B. Hart, N. P. Clement, 290 Linwood Ave., directors, have awarded the contract for 14 story, bank, store and office building on Main and Genessee Sts., to Turner Constr. Co., 244 Madison Ave., New York. Estimated cost $2,000,000. Noted June 13.

N. Y., New York — The New York Tribune, Inc., 154 Nassau St., has awarded the contract for 7 story office building, etc., at 219 West 40th St. to James Stewart Co., 30 Church St. Estimated cost $500,000. Noted June 13.

N. D., Dickinson—The city has awarded the contract for 25 hp. oil engine for the water department, to Fairbanks, Morse & Co., Park Sq., St. Pau, Minn., $1,754; double stroke deep well pump to the Union Iron Works, Main and 2nd Ave., S.E., Minneapolis, Minn., $2,253. Noted May 16.

Ohio, Cleveland—The Penton Publishing Co., R. E. Powers, Pres., 1136 Chestnut Ave., has awarded the contract for 9 story, 135 x 135 ft. publishing plant, on West 3rd St. and Lakeside Ave., to the Hunkin-Conkey Constr. Co., New Century Bldg. Estimated cost $500,000. Steam heating system will be installed. Noted June 13.

Ohio, Columbus—The Bd. Educ., E. L. McCune, Clk., Towne and High Sts., has awarded the contract for 3 story, 200 x 400 ft. Washington Gladden high school, also 2 story, 278 x 327 ft., Edward Orton high school on Arcadia Ave., to R. H. Evans & Co., Ferris Bldg., $849,430 and $663,900 respectively. Noted June 6.

Ohio, Columbus—The Bd. Trustees, Childrens Hospital, F. O. Schoedinger, Chn., has awarded the contract for 4 story, 147½ x 154 ft. children's hospital on 17th and Stone Sts. to D. W. McGrath & Sons, 255 East Broad St., about $325,000. Noted May 9.

Pa., Williamsport — The John Peters Packing Co., 1320 East 3rd St., has awarded the contract for 4 story, 68 x 68 ft. cold storage plant, on East 3rd St., to Turner Constr. Co., 244 Madison Ave., New York. Noted June 27.

R. I., Pawtucket—The Hope Webbing Co., 1005 Main St., has awarded the contract for 6 story, 85 x 190 ft. addition to mill building, including steam heating system, to the C. S. Cunningham & Sons Constr. Co., 80 Boylston St., Boston, Mass. Estimated cost $200,000. Noted June 20.

S. D., Sioux Falls—The city has awarded the contract for filtration station: iron removal plant, 8,000,000 gal. daily capacity, to A. Fanebust, $52,666; well, pumping machinery, etc., $7,885.

Va., Ashland—The city, c/o C. Stebbins, has awarded the contract for settling basin, two 80 gal. tower and tanks, filtration plant and 2 triplex pumps to the Pittsburg-Des Moines Steel Co., Curry Bldg., Pittsburgh, Pa.

Va., Danville—The Dan River Cotton Mills has awarded the contract for 4 story, 148 x 300 ft. bleachery and finishing plant to J. P. Pettyjohn & Co., Lynchburg, $450,000.

Wis., Manitowoc—The Bd. Educ., E. Kerwan, Secy., has awarded the contract for 3 story, 240 x 419 ft. high school, to Theo. Stark & Co., 130 Huskego Ave., Milwaukee, $410,700. Steam heating system will be installed. Noted June 6.

Wis., Milwaukee—The Milwaukee Elec. Ry. & Lt. Co., 2nd and Sycamore Sts., will build 32 x 73 ft. sub-station on Milwaukee St. by day labor. Estimated cost $12,000. R. H. Pinkley, c/o owner, Engr.

Ont., Ottawa—The Ottawa Hydro Power Co., 109 Bank St. has awarded the steel contract for sub-station on Carling Ave. to Dominion Bridge Co., Sparks; brick and masonry to J. A. Sutherland & Sons, 416 Gilmans St. Estimated cost $180,000. Noted June 6.